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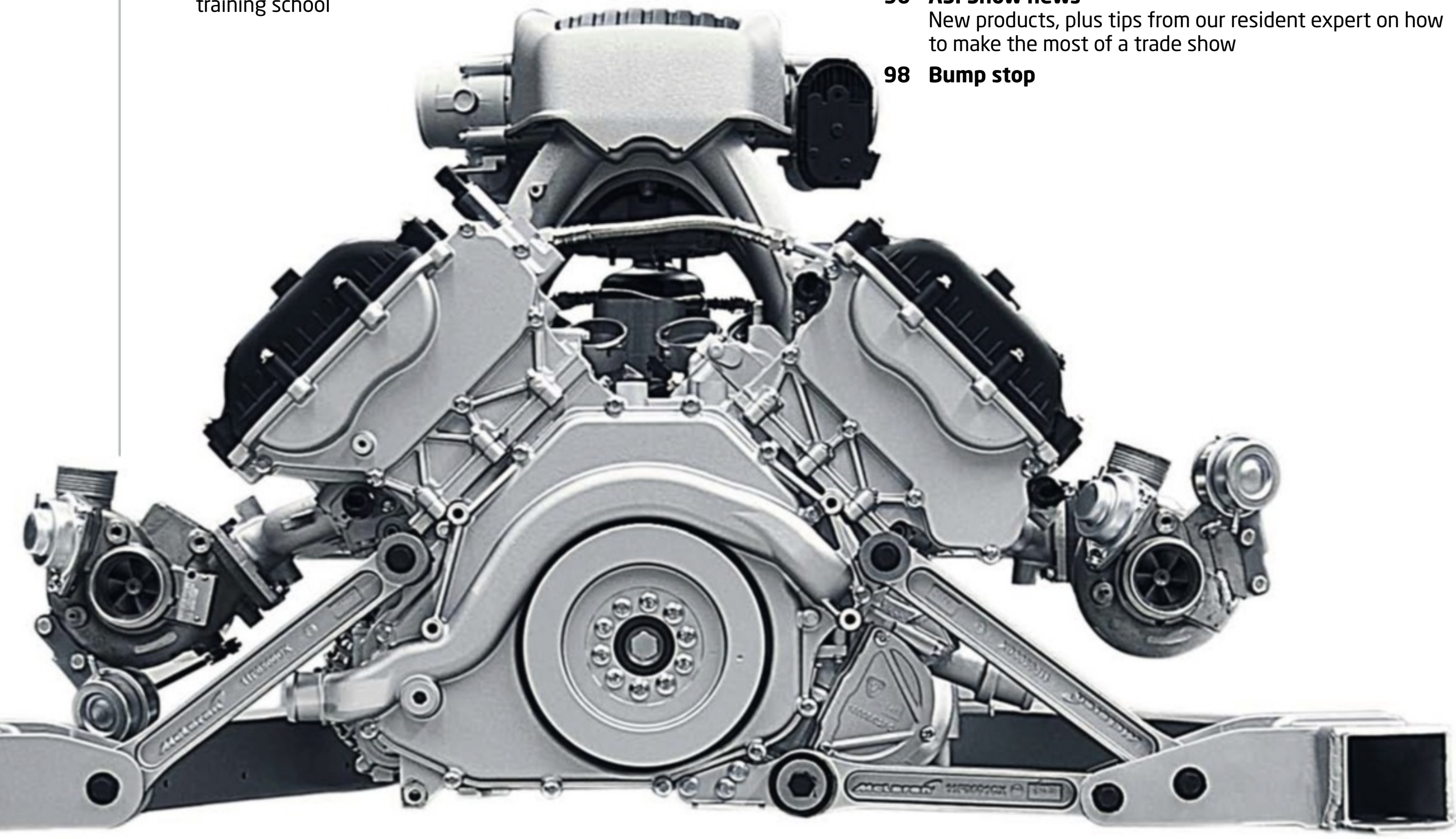

Beauty redefined

Form and function versus aesthetic pleasure

'Form follows function' can be an aesthetic point of view that a design can heighten, as often seen in the work of Ettore, Rembrandt, and Jean Bugatti. The saying can be attributed to the American sculptor Horatio Greenough, who in 1852 was relating it to the organic principles of architecture.

It could be applied to racing cars built in those days before the widespread use of wind tunnels. Then, builders designed with what Marzotto called 'optical intuition'. After the wind tunnel, we can say all cars of a class look the same, form locked in by function.

Anatomists regard the retina as a part of the brain that is located outside it, having been sequestered from it early in development but having kept its connections with the brain proper through a bundle of fibres – the optic nerve. One could postulate that the retina does some thinking, the phrase 'pleasing to the eye' attesting to this.

Each individual will have their own preference, so the chance of reaching a universal consensus is equal to one over Graham's number, which is unimaginably larger than other well-known large numbers such as a googol, googolplex, and even larger than Skewes' number and Moser's number.

Indeed, like the last three numbers, the observable universe is too small to contain an ordinary digital representation of Graham's number, assuming each digit occupies at least one Planck volume. The last 10 digits of Graham's number are ...2464195387.

One's particular absolute beauty can be defined as the Ferrari P3/P4, while modern F1 cars can be relegated to Quasimodo's Home for the Visually Unpleasant. Not the designers' fault: they have been cursed by Rules Disease, forced by legislation to accept teratological forms to achieve good L/D.

But that is my assessment, which depends on my preferences, as in 'All criticism is a form of autobiography.' Obviously, this isn't absolutely true. Criticism is often about formal matters: How many lines are in a sonnet? What is lyric poetry? How did Amadis of Gaul influence Don Quixote? These are questions that can lead to criticism that is only trivially autobiographical.

We are not simply hedonic machines who thrive if supplied with things that tick certain boxes for sensory pleasure and aesthetic merit. Mill could say a word about utilitarianism, but in much the same way, design can look at the coffee-making process and systematically remove all that is problematic in it. The result is something flawless, but a particular and limited form of excellence or perfection. Perhaps there are peaks above perfection that can be achieved only by accepting a certain amount of imperfection, but tickle the aesthetic glands....

This does not impede cases of emotional incontinence in road cars, of course, where there is styling overkill. Some styles can be overwrought, but not improve on the impact, much as 10 instruments sound only twice as loud as one and why 100 instruments only sound four times as loud as one. It doesn't make sense. After all, six smelly socks aren't six times as smelly as one, and 10 salted peanuts aren't five times as salty as two. This, interestingly, relates to survival by the avoidance of danger. Our brain will choose to what it pays attention based on how threatening it assesses the noise to be.

The 1930s was the epitome of that. Figoni et Falaschi, Chapron, Franay and de Letourner et Marchand, Saoutchik... Never was car styling more baroque, maybe the influence of Art Nouveau, whereas a Mercedes SSK or a Blower Bentley were nothing but odes to testosterone, much like more recent American musclecars.

The Ferrari P4, here racing at Le Mans, remains a firm aesthetic favourite

Penis substitutes can characterise some cars, others can be likened to the sensuous curves of a woman's hips with the requisite hip-to-waist ratio that denotes fertility. The D type Jaguar has both attributes: witness the long hood and lines of the rear fenders. One wonders if the shape of current hypercars, which emphasise fat rear tyres and a voluptuous rear end, are the trickle down of the Id. Maybe that's just me.

As a digression, one blames Tonka toys for the look of modern cars, albeit with a tempering of better aerodynamics, and a touch of *Mad Max* (the film, not the person who...). So are the whims of style made, with the celluloid dreams of 'La racaille'.

Modern F1 cars can be relegated to Quasimodo's Home for the Visually Unpleasant

One of my aesthetic amusements is to see new cars and predict how they will age. Some are beautiful decades later, if not half-centuries. (The original horseless carriages of a century ago do not really qualify; they were in the epoch's paradigm, a carriage but without the horses – a distinct example of Skeuomorphism, which is parallel to, but different from, path dependence in technology, where functional behavior or appearance is maintained when the reasons for its design no longer exist.)

The concept of skeuomorphism overlaps other design concepts as well. Mimesis is an imitation, coming directly from the Greek. Think go-faster stripes on production cars, scoops or fins.

On the other hand, the resurgence of retro-styled road cars attests either to the lack of new ideas, a revulsion against the jelly mould shape of an aerodynamically sound car given a size, or a celebration of the beauty of some old masterpiece.

None of which excuses the F1 grid nowadays. But I will contradict myself, and consider that a beautiful racing car is the quickest one. CFD plus good surface modelling makes today's F1 cars beautiful in the details, even if narrow tracks, silly rear wings and platypus noses detract from the aesthetic experience. Shame about the clone look created by extreme engineering and rules. Spray them all grey and tell me which team runs which one.

Style is like the proverbial walking, quacking canard, easily spotted, like pornography in the words of one judge: 'I cannot define it but I know it when I see it'. In the Dialogues, Socrates describes Plato stating the trinity of Good, the True and Beautiful: independent, celestial essences, inextricably inseparable. I could go as far as stating that if it does its function well, it is beautiful, thus transforming all racing cars into vessels of beauty.


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The creeping curse

Is uniformity spoiling the spectacle?

My visit to the amazing Goodwood Festival of Speed this year reminded me of the tremendous variety that motor racing used to display in sight, sound, action and character. Despite not being a competitive event, it's this wonderful pantheon of two- and four-wheeled racing machines and their idiosyncrasies, along with the personalities involved, that brings in the enormous crowds.

In contrast, one of the biggest gripes against current motor racing from TV viewers and fans alike is the lack of sufficient spectacle, especially in Formula 1.

In reaction to this, attempts to spice up the action in the premier category have achieved some success, although we have seen that deliberate manipulation of the rules can backfire and lead to an almost farcical opposite of what was genuinely intended.

Conversely, the constantly increasing regulation of what is permitted, in both chassis and engine design, has inevitably led to that dreadful curse of the modern world: uniformity.

Almost nothing can artificially produce consistent close racing at the front. There will be times when a certain driver/team/car combination will reach that magical amalgam of competitiveness that is virtually unassailable, as is the case right now with Sebastian Vettel and Red Bull. Other than specific handicaps such as extra weight being applied (shudder), it will always happen.

Therefore other factors must contribute to maintaining viewers' and spectators' interest and excitement in the racing. In the October publication, the Editor pointed out a number of initiatives which would result in events being better promoted for the spectators. But for TV especially, where the focus rightly is on the track action, a lot of spectacle has been lost to the sport by creeping uniformity.

One of the aural pleasures of racing cars used to be not just the sound of the engines, but the discernible difference between them. Take F1 again. One can't totally turn back the clock, but those old enough to recall the rasp of a Ferrari V12, the melodious BRM and screaming Matra, flat grunt of the DFV V8 and insane Honda howl competing together will know what I mean.

With your eyes shut, you could tell which car was which and delight in the variety. Despite the incredible revs of current F1 V8s, unsurprisingly they sound much the same given that they all have a mandated number of cylinders and valves, bore size, rpm limit and much, much more. The only differentiation is caused by the exhaust system and the ECU mapping, generally only briefly noticeable.

Variety is the spice of life. Or rather, it was in 1976

This uniformity imposed on engine designers must be hugely frustrating and quickly becomes boring, lending credence those who describe motor racing as 'just cars going round sounding whah, whah, wah...'.

Imagine if the combustion engine part of the new powertrain rules was more open. Some manufacturers might opt for four instead of six cylinders, maybe five or even three. Even with a turbo, they would sound different, especially if the exhaust system were more free.

Cost is always raised as the reason for such innovation-strangling measures. With the incredibly sophisticated simulation tools available, I don't buy that. Most would probably end up with a similar (but not identical) configuration, but at least it would leave room for individual genius to come up with an alternative.

The extra cost passed on to teams resulting from more engine design freedom could probably be balanced by sensible actions such as stopping hugely expensive race-by-race aero developments. Mandating the homologation of parts before the season starts and then allowing only two more re-homologations thereafter would represent a huge saving.

Race starts at least used to be full of spectacle – tyre smoke galore, revs rising and falling, cars sideways as the rear tyres struggled for traction, weaving around cars slower off the line and often a radical change of order going into the first corner. Brief, but adrenalin-infusing. Have you noticed how that's changed?

With complicated software-assisted clutch preparation pre-grid and multiple bite points just short of full launch control, cars go off the line almost in order (Fernando Alonso excepted!), the wheelspin reduced electronically to the minimum and the cars kept straight as an arrow, removing what should be one of the key skills of a racing driver and the chance of gaining an advantage. What an anti-climax after all that pre-grid tyre warming and engines being held on the limiter until the lights change! It is an unnecessary piece of expensive and irrelevant technology that is contra to spectator excitement, and spoils an important part of the show.

Blame not just the Technical Regulations. Under the Sporting Regulations the over-enforcement of penalties without regard to circumstances can ruin a great fight between protaganists on the track, which might enliven a race even if the lead is not in dispute. I'm disappointed with some of the former drivers appointed as stewards. They should know the difference between an advantage unfairly gained versus a genuine wheel-to-wheel battle that can occasionally result in a car briefly going off-track, a move that is a bit opportunist against one that is downright dangerous. 'Rules are rules', the argument goes and should always be applied uniformly. Rubbish – if it is as black and white as this, then let computers hand out the punishment. Who needs human assessment and judgement, and dare I say it, common sense?

Racing is meant to be a bit hairy and if drivers and others aren't prepared to accept this then they should seek an alternative occupation. Uniformity has its place in the establishment of regulations that allow similar machinery to participate in races worldwide, in the circuit safety standards and training of marshals and other personnel; i.e. the fundamental structures under which the sport can take place with responsibility and practicality. It should not be there to stifle creativity, exceptional skill and daring, and detract from the spectacle. Increasingly, via the obsession with uniformity this is precisely what is occurring.

Imagine if the combustion engine part of the new powertrain rules was more open

The fastest cars in the East?

Super Formula's SF14 is the car tasked with turning a domestic championship into a top-level Asian racing series

BY SAM COLLINS

The aim was to create an engine which balances environmental performance, power and fuel efficiency

STUDIO IMAGES: HINDENOBU TANAKA/AUTOSPORT JAPAN

We want to be faster than Force India' was the challenge set by Hiroshi Shirai when he announced that in 2014 Formula Nippon would undergo a huge transition. He revealed a vision of the future that saw the series grow from being a domestic Japanese championship to a regional equivalent to GP2 or IndyCar, just a lot faster. The first step in this process was to change the name from the very nation specific 'Formula Nippon' to the more general and rather more exciting 'Super Formula'.

The second stage of Shirai's plan was to introduce an all-new car. The last car, built by Swift (the first fully developed for the category, as the previous Lola was an updated F3000 design), had served for a number of years but was due for replacement. The question was, who would develop the new machine? Local constructor Dome had ruled itself out for political reasons – it did not like the spec chassis concept – while some teams were not keen to purchase a car and parts from the USA. Lola, the previous partner of Formula Nippon, was on paper a logical choice but was in its death throes, despite having a perfect design, the MB-01 World Senior Car, on the drawing board already.

After reading an article on the new Super Formula concept in these very pages, the commercial staff at Dallara got in touch with JRP and ultimately won the contract, and work began on finalising the design brief for the new machine, which was to be called the Dallara SF14.

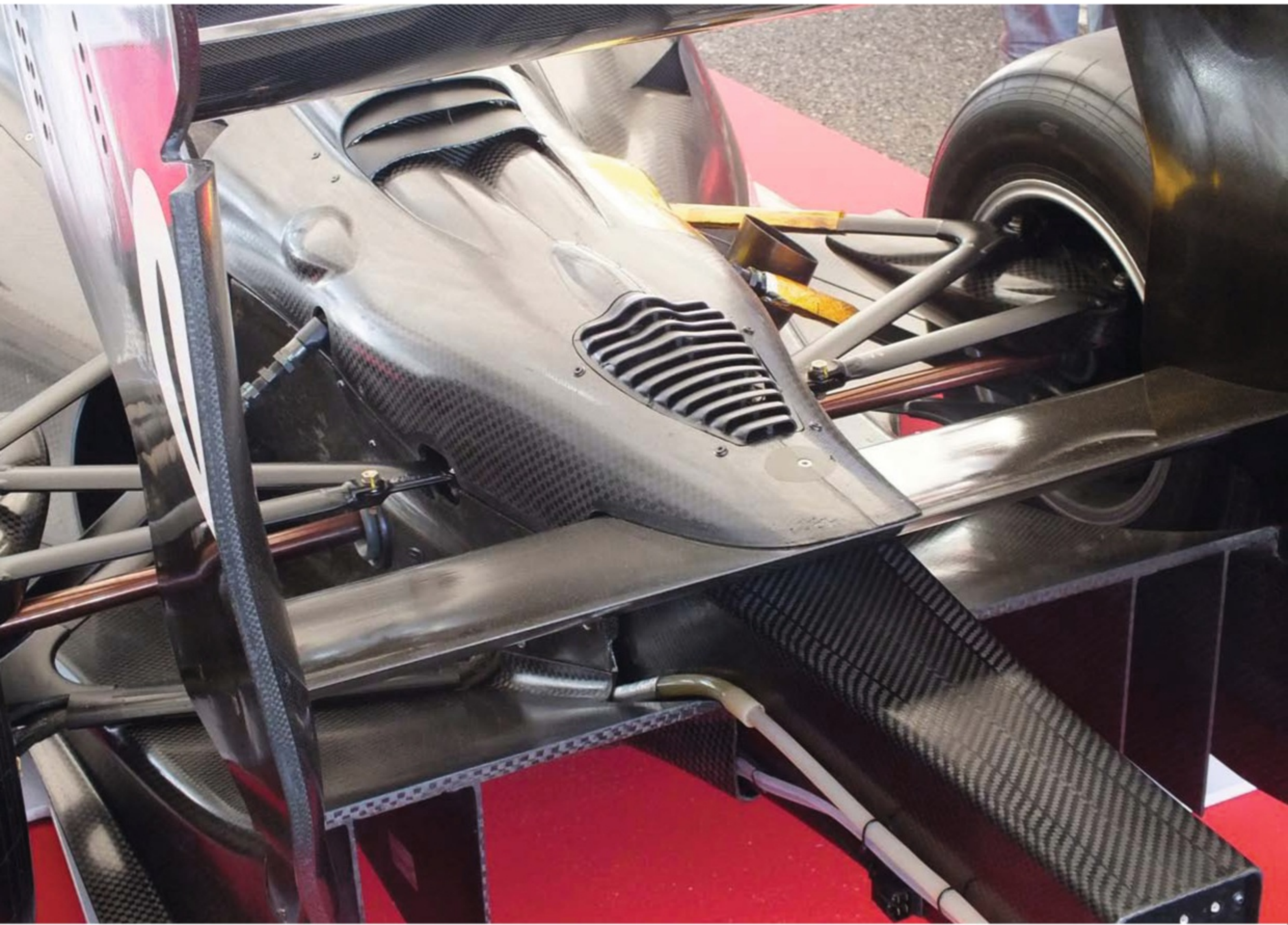
'Quick and light' was the development concept for the SF14 set by series promoter JRP; the cars must also be hybrids. The idea of being as fast as a 2013 Force India F1 car was deemed unrealistic within the budgetary constrains of the SF14, although the car is still thought to be very potent.

'They came to us and told us that they wanted a car with Force India pace, but then we explained to JRP what that really meant,' reveals Luca Pignacca, Dallara's chief designer. 'The car will be quick, but we are not sure how quick as the engine has not shown its full potential yet.'

JRP was aware that a leading vehicle's aerodynamic wake can make it difficult for a following vehicle to pass, so in the initial brief it asked for DRS to help overcome this effect and facilitate more overtaking.

'We wanted to give the car good styling, but we did not want to do anything too big and not required. I have a lot of respect for Swift on the old car using a front wing so big and different; it was a brave move but it seems that the old car does not overtake that well,' Pignacca says. 'We have tried to make sure that this car will be good for overtaking, but it's a bit of black magic really. We are not yet sure if it will work, but over the years we have discovered a lot on this.'

Dallara's engineers decided that it would be better to create a car that generated a substantial amount of downforce from the



Rear packaging for a spec chassis designed to work with three different engines, although only Honda and Toyota have tested

floor, a ground effect approach also employed on Dallara's first GP2 cars. There would also be a form of push to pass on the powertrain.

The SF14 weighs in at 650kg with driver, which makes it the lightest top class open-wheel car in the world: it is 60kg lighter than the old Swift 01.N Formula Nippon, now often erroneously called the SF13.

'In the first instance we focussed on making this car very safe, meeting the F1 2010 crash test standards, but we also had to meet the request of the car weighing 650kg. That was a big challenge to achieve; we also had to work out the aerodynamic and weight balance against the mounting of the hybrid components which were not yet finalised,' Dallara Super Formula manager Walter Biasatti explains.

'Our main challenge involved meeting the FIA F1 2010 safety regulations; but the real challenge lies in packaging the car itself. The fact that we had to install a KERS, the servo-steering, two different engines, and three pedals instead of two...It caused no end of headaches!'

The overall design of the car is visually – and in some ways conceptually – very similar to the current Dallara GP2 design, and in many ways is fairly conventional. 'In aerodynamic terms the car is not all about downforce as the tracks in Japan reward efficiency rather than total downforce, so we pushed in that direction. The circuits in Japan are neither low drag nor high downforce, just mid range,' Pignacca says.

People started to ask whether Toyota's racing division was a waste of money

The SF14 is slightly longer and wider than the GP2 car and has a longer wheelbase, while is also lighter. With its KERS boost on it produces more power than the European-spec racer, although the introduction of that system has been delayed, as Honda and Toyota want to employ different systems.

'We had to design into the chassis to accommodate the battery pack and the inverter, so we just need a bespoke bellhousing and the car can accommodate the Zytek KERS package very easily, though it will not run with it initially,' Pignacca adds.

The heart of the SF14 is its engine, something Pignacca is highly enthusiastic about. 'The package is a dream for a racing car designer,' he says. 'It is the same size as an F3 engine but producing nearly 600bhp. It's so nice for such a small engine.'

Built to all-new regulations, the Next Racing Engine (NRE) is an exercise in downsizing and includes all of the current themes of cutting edge powertrain development such as direct-injection and turbocharging mated to a hybrid system. The NRE regulations are shared between Super Formula and GT500, allowing the manufacturers to use the same engine in both of Asia's top racing classes.

The previous car had a big, bold front wing, but Dallara went for a more subtle design with a view to helping drivers to overtake

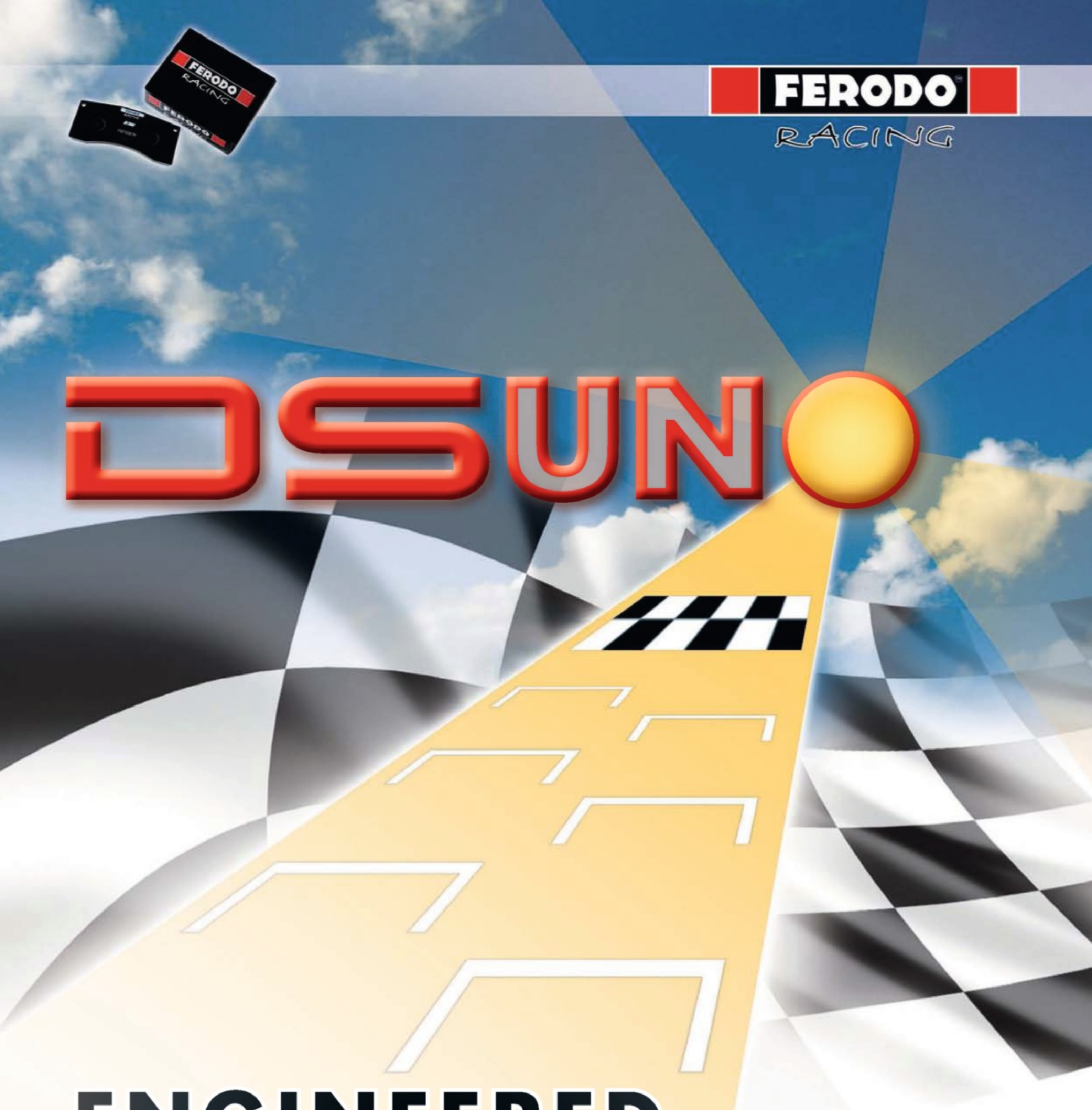
A closer look at key components of the SF14, including the front and rear suspension struts, a front wing endplate, and the sidepods. The design targets were to make the cars suitable for mid-range downforce circuits and to help overtaking, while maintaining the speed of the Force India Formula 1 car. Almost all of these design parameters were met – the only one missing was the outright speed, although the car is still quicker than an IndyCar.

Honda, Toyota and – to an extent – Nissan wanted the NREs to be different to the turbocharged engines of the past, which were seen as ignoring efficiency and fuel consumption in the pursuit of power.

Instead, the motto behind the development of NRE was 'to create an engine which balances environmental performance, power and fuel efficiency.' As a result, the NREs differ greatly from previous turbo engines used in racing, and are quite close in concept to the new power units being employed in Formula 1.

All engines built to the NRE rulebook are inline fours with a 2000cc displacement. A single spec turbocharger is used and all engines feature direct injection. At the time of the NRE concept's creation, they would theoretically produce in excess of 550bhp and were predicted to improve SF14 lap times by almost three seconds when compared with its V8 powered predecessor. On paper, these times were equivalent to those produced by grand prix cars.

'I was previously involved in the development of F1 engines, and at that time I was amazed at the technology which enabled the engines to reach 20,000 revs,' explains Shinnosuke Sato, one of the lead engineers on Toyota's NRE project. 'But when I thought about this further, I began to question whether there was really a need for an engine to have the technology to reach 20,000 revs in the first place. Furthermore, with the 2008 financial crash, people started to ask whether the racing division was a waste of money for the company.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'But with this new engine we can proudly say that we are developing technology which contributes directly to the future of mass produced engines,' Sato continues. 'This makes me feel happy. In the beginning, motorsports divisions were established as a testing ground for the evolution of technology of mass-produced vehicles. However, as the racing technology became more refined and into its own, it moved further away from the technology of mass-produced vehicles, and the connection between the two became weaker. This new objective to "balance environmental performance and power" has reunited this connection between motorsport technology and mass production technology.'

But for an engine formula the change is fairly drastic; both GT500 and Formula Nippon have always used fairly large displacement normally aspirated V8 engines, such as the ubiquitous Toyota RV8K found not only in the two aforementioned categories, but also in LMP1 & GT300. To downsize to a two-litre inline four is a major change in architecture for both the engine and chassis.

The new car is the lightest top class open wheeler in the world, weighing in at 650kg including the driver, yet meets F1 2010 crash test standards

The displacement of the engine was decided jointly between JRP, GTA (which governs Super GT) Honda, Toyota and Nissan. It would have to be capable of being fitted to a car weighing around 950kg and still produce lap times similar or better than those currently seen in GT500.

'Having multiple cylinders is a method to get higher engine speeds. Normally aspirated engines need high revolutions to produce power, however with a turbo-charged engine there will be torque at low revs, which means that high speeds can be produced without the need for high revs. So we came to the conclusion that a lower number of cylinders in the form of a four-cylinder would be perfect,' explains Naoki Miyajima, another of the Toyota NRE engineers.

The manufacturers making NREs have all highlighted the opportunities for technology transfer from race to road, but as Miyajima reveals, the process also works the other way. 'We gathered the information from the mass production division regarding the direct-injection turbo, but we knew that the only way to find out whether it would work was to create it. So last year, we used a bank of the current V-type engine, created an engine for actual testing and ran it. This is the great part of motorsports: to be able to work in small teams and to create and test new ideas. I believe this sort of activity helps to develop our personnel.'

A NEW DESIGN METHODOLOGY

The SF14 is the first car Dallara has developed using a new virtual design approach, testing and developing the car's design in the digital environment on its state of the art simulator before manufacturing any parts.

'The SF14 is the first car that we have defined "virtually"; i.e. defining the principal design parameters before even writing the first line of the project, and it has proved to be a highly efficient way of working,' explains Alessandro Moroni, the man in charge of Dallara's simulator project and one of those pushing this new design approach. 'This new approach is a definite advantage for the project.

'The first SF14 driver to try the simulator was Toyota's Kazuki Nakajima, who already had some experience of other simulators and so had some idea of what to expect. This meant that he was ready to go right from the start without any need for acclimatisation. A few weeks later it was Honda driver Takuya Izawa's turn. He had never been in a simulator before so needed to be 'broken in'; but after a couple of hours he was already fully operational. Both drivers carried out the same tests, so as not to give either an advantage over the other, completing over 100 laps each.

'In order to establish a frame of reference, they tested their current cars on the Suzuka track, after which they tested various configurations on the SF14. Some of these were then adopted as solutions to be implemented on the "real" car: this is the great advantage of the simulator, the fact that it is possible to be certain about various aspects of the configurations before taking them out onto the track. Both drivers' times were the same as they regularly achieve on the track, but more importantly the feeling was the same as they are used to experiencing in the real cars.

'Normally, when drivers use the simulator for the first time, they tend to say things like "the simulator did this, or that". However, when they really start getting used to it, this changes to "...the car understeers, the car hasn't got enough traction...". This means that the simulator is really doing its job and that the drivers feel as though they are driving a real car. This is exactly how the Japanese drivers reacted.

'The basic idea of our simulator was to create a test bench capable of reproducing the car's performance, or rather its effect on the driver. A realistic test bench that would make the drivers feel as though they were actually driving the car. In other words: in the event of a skid, they must react as if they were on the track, and the mathematical model of the car will respond as the real car would on the under real conditions.

'If the system does not fulfil this aim, drivers will react as if they were playing a simple videogame, and the chances are that the input they provide the model with would not correspond to reality. And that, in a nutshell, is the engineering value of a simulator,' he adds.

'In a company like Dallara, the simulator is effectively used to collect information from all the other departments. That imposes and promotes interaction between different departments.

'Since it is necessary to create a model that represents the entire vehicle, each sector responsible for providing a certain feature of the car – designing the suspension, calculating the aerodynamic performance on the computer, performing measurements in the wind tunnel, etc., – is obliged to work towards completing the model that will be used on the simulator.

'The simulator is like a mirror image of the real car: the various sectors work for the simulator, in the same way as they would on the finished car, while the simulator also works for the different departments by evaluating the effectiveness of an aerodynamic solution or a suspension system designed in a certain way, together with the driver. It was crucial on the SF14.'

The SF14 has tested in public, running at an estimated 90 per cent power and not without teething problems

That first test of the Toyota NRE took place using a single bank of an RV8K; it was not just run on the test bench but it also ran in the back of Toyota's Swift Formula Nippon test car mated to a kinetic energy recovery system. A turbocharger was also fitted to the half-V8 testbed engine despite the fact that the block was not designed for it - indeed, nor was the chassis - and the turbo and intake protruded from the left sidepod of the Swift.

Mirroring the rule changes in WEC and Formula 1, it was deemed important that both GT500 and Super Formula races were determined by sheer speed. However, the manufacturers insisted that the engines were still able to 'balance environmental performance, power and fuel efficiency.' To this end it was decided that if this new fuel-efficient turbo engine was to be competitive, there was a need to focus not on the total amount of fuel used, but rather on the management of instant fuel consumption.

If this instant fuel consumption was not managed, more power could be achieved simply by pumping more fuel into the cylinders, as was the case with the conventional turbo engines of the past and which is the exact opposite of what they wanted. But if the fuel flow was restricted, it would put the emphasis on producing performance from fuel-efficient turbochargers: something that could be directly transferred to production cars. JRP was well aware of the fuel flow metering systems planned for introduction into F1 and WEC in 2014, but it wanted the fuel flow to be restricted, not just metered.

Toyota project leader Yoji Nagai came up with the idea of an instant fuel restrictor mechanism. But colleague Junya Tanaka, a fluids expert, believed from the start of the project that it may not be the right route. Typically in racing, air restrictors are used to limit performance. If liquid fuel is regulated in the same way, by narrowing down the flow rate, the fuel may vaporise and cause uneven fuel delivery. This in turn could lead to misfires under full power, which in a race could lead to a sudden loss of speed and rear-end collisions.

Tanaka raised his concerns with Nagai, and Nagai realised that he was right. After simulations proved Tanaka's theory, work went into developing a fuel flow restrictor. Not only does this restrictor raise an interesting conversation in Formula 1, which some reports say is struggling with the implementation of its fuel flow meters, but it also cuts costs for the engine suppliers in both Super Formula and GT500.

'I have been in charge of Super GT at Toyota, and although both Super Formula and GT500 have the same engine [RV8K], the GT specs differed as it has an air restrictor,' adds Miyajima. 'At TRD we created a specific piston and intake system for the air-restricted engine to cater to the GT series. From now on, the engine will be exactly the same spec in both series. Development and maintenance will be simpler, since the change to the fuel restrictor system means that it is all essentially the same for both. Of course, since the weight of the car and the flow restriction differ, the way in which it is used may also differ. However, since the cost has been dramatically decreased, I would like to think that this technology would become widely used in the future.'

Once the first engines from Toyota and Honda were ready they were installed in a pair of otherwise identical SF14 chassis, and sent for their first public runs. That shakedown test for the SF14 was not without its setbacks; the cars were fitted with a manual gearshift rather the Zytek paddle shift system that will be used on the actual race specification cars (see p17). The new engines were not quite delivering all they could.

'It was just a shakedown run, so problems are there to be found and it does not really matter,' Nagai contests. 'The engine output was probably only about 90 per cent of what it should be, and overall the shakedown achieved about 80 per cent of what you might say was a passable performance, but we are on schedule.'

Meanwhile, the shakedown tests for the GT500 versions were also not without hiccups, but that will be detailed in a later issue. Despite teething troubles, the Dallara SF14 was almost immediately faster than the V8-engined Swift Formula Nippon design in race trim at the same track. To show how quick that is, the old V8-engined cars were notably faster than the previous generation of IndyCar, although perhaps not quite as fast as Force India's VJM06.

The SF14 will race for the first time in the spring of 2014. If and when the races prove to be successful, the third phase of Shirai's vision will start to be developed: the expansion of the series around the Asia-Pacific region. Ultimately, Shirai hopes that Super Formula will be seen as being second only to F1.

TECH SPEC

Dallara SF14

Gearbox: 6-speed Ricardo, Zytek paddle shift

Brake: Brembo carbon/carbon

Front tyre: 235/55R13 Bridgestone Corporation
Rear tyre: Bridgestone 340/620 × 13

Monocoque: Carbon fibre monocoque with Aluminium / Nomex honeycomb core, with Zylon inserts

Bodywork: Carbon composite Nomex honeycomb core

Steering system: Kayaba electric power steering

Front Suspension: Pushrod actuated dampers with torsion bars
Rear Suspension: Pushrod

Safety spec: FIA-2010 F1

Total length: 5268 mm
Wheelbase: 3165 mm
Width: 1900 mm
Overall height: 950 mm
Weight: 650 kg with driver

Engine:
Manufacturer: Honda or Toyota (Nissan also makes a suitable engine)
Number of cylinders: 4 (inline)
Fuel injection system: direct injection
ECU: Cosworth Electronics
Induction: Turbocharger (one spec)
Displacement: 2000cc
Output: Approx. 550hp
Weight: 85kg

Quick change

The introduction of the new Super Formula also sees British company Zytek upgrade its electronic gearshift system

BY ANDREW COTTON

British company Zytek has introduced a lighter, smaller and more adaptable version of its electronic gearshift actuator for the new generation of Super Formula cars that will make their debut next year. The system was first introduced in 2003, when Zytek submitted a tender for the GP2 contract. That bid was not successful, and so instead the company sold the second-generation system to A1GP and the Formula Nippon series, which has been running faultlessly with them ever since.

The new Super Formula cars are already testing with the third generation gearshift mechanism, which is estimated by the company to be around 30 per cent smaller and with greater capability to talk to different systems in the car. The system works by drawing power from the battery or alternator to charge up capacitors, which then deliver the short, sharp burst of power needed to change gear.

The electronic gearshift (EGS) was used on the Honda GT500 contender before the new generation cars for 2014 were built using the same suppliers and concept as the DTM, which means that Hewland picked up the supply contract.

The EGS is also used on the GT300 CR-Z GT, which won its class at the third round of the Super GT series in Sepang in June, using the ZPH Zytek Hybrid System. Also running the system are the Zytek LMP2 chassis and the Auto GP machines. 'The trick to our system is that it is powered by the 12V system,' says Zytek's Ian Lovett, technical director of Zytek Engineering.

'Upshifts typically occur every two or three seconds with downshifts happening several times within one second, and our systems draws a discreet amount of current after each shift. Once the capacitors are re-charged it stops drawing.

'The technology that is available to store the technology has not changed massively, so much of the evolution is centered on the circuit board componentry and layout to minimise volume and mass for a given performance. Additionally we have been able to add levels of technology to improve how we interface with different engine management systems and apply cuts to manipulate the torque on the dog rings to effect a gear shift.'

The design of the solenoids was undertaken by the same engineers who designed the kinetic energy recovery system that was first used by McLaren

The third generation gearshift mechanism is around 30 per cent smaller and with greater capability to talk to different systems

Zytek's third generation electric gearshift actuator works by drawing power from the battery to charge super capacitors, which store up the energy needed to change gear every two or three seconds

'In a similar way to KERS, it stores energy inside itself.'

in 2009. 'Even though they are linear actuators, they rely on the same expertise to get certain performance from a certain amount of electric power,' says Lovett. 'Zytek Automotive design the control unit, so that in a similar way to KERS it stores energy (though in this case drawn from the car battery) in capacitors, and when a gear shift is requested it discharges those caps to a certain level to generate the force in the actuator to shift gear or blip the throttle.'

Zytek did investigate an LMP1 hybrid using super capacitors, but the main problem was that capacitors take up a lot of space, and Zytek did not find a viable solution to packaging in its 09S. 'It depends how much you want to store,' says Lovett. 'If you want a short, sharp pulse, you can store it in a relatively small space. An additional complication with capacitors is that as they discharge, the voltage changes from high to low quite quickly, while a battery is easier to control from this point of view. This issue is not as critical in the gearshift, because it is a relatively small amount of energy that you are storing – all you are looking to do is actuate the gearshift, whereas if you are assisting the performance of the whole car the energy required is massive.'

ZYTEK TECHNOLOGY: ROAD READY

With an automotive and engineering department, Zytek is perfectly placed to consider the transfer of technology from race to road, and vice-versa. An industry leader in battery technology, thanks in part to its link with German company Continental, it was one of the first to build a hybrid car for Le Mans, the Panoz Q9, which took part in pre-qualifying in 1999 and later raced at the Petit Le Mans. It also worked with Gordon Murray to produce a lightweight drivetrain, battery, and vehicle systems for the T27 electric city car, also with Mercedes on the Smart ev, and with Chrysler/Dodge, producing the engine control systems for the Viper that it still runs today.

'Automotive, and its involvement in electric and hybrid ended up working on KERS from a core functionality point of view, the motor design and build, while engineering support us on the mechanical side, and we work together with those solutions,' says Zytek Automotive managing director Neil Heslington. 'I think in the past, with the exception of ABS, it has been difficult to substantiate the link between race vehicle systems and road car systems, but I have to say that working on the F1 KERS for 2009, the passage of technology from that race experience through to emerging road car technology is very strong.

'It is all about performance, energy management, and lightweight materials. The needs of the racecar are similar to the needs of the road car because you have got to be managing your energy efficiently. You have to accelerate a lighter vehicle around, so there are strong associations and that is good. It continues that way with our relationship with Honda – the KERS there, it is the same: how you can manage your energy using light weight in the energy management system, how to get the battery light, inverter light. You have just introduced a motor, inverter and battery into a system where you didn't want any extra weight.

'Because we work on race and road programmes, every drop of energy that is put on board the vehicle will be managed by a system to get the most out of it, whether that return is ultimately in range, or performance, as comfort and entertainment are energy consumers – it is all about managing energy. In race terms we are less concerned with audio and the like, but in terms of performance of the vehicle and other associated systems, cooling systems for example, that is what we are looking at.'

Baby boom

McLaren has produced a track day car to rival the best production cars that money can buy as it expands its racing product range around the MP4-12C

BY ANDREW COTTON

The McLaren MP4-12C GT3 car has developed an unfortunate reputation. From a troubled inception, this year it has had problems at some high profile races, including at the Spa 24 hours and at the Nurburgring where the engines failed, although these were not necessarily the fault of the manufacturer. What it has meant is that McLaren is facing a battle to have its car recognised for some significant achievements in racing. Despite the problems the bare facts are that the model has entered 90 races in 2013, taking 237 starts. In those 90 races, the MP4-12C has scored 21 pole positions and 51 podium finishes, including 20 race wins.

EXPANSION PLANS

One of the major problems facing the 12C in the GT3 class is that the 3.8 litre V8 engine is turbocharged, the only turbo engine competing in the GT3 – or, indeed, the GTE category – and balancing the performance has been a voyage into the unknown for McLaren and for the rule makers. That did not stop the company pressing even further ahead with its expansion into the GT classes, with plans for a GTE programme, but pulled the plug on the project as the GT convergence talks started and the company considered that the shelf life of the car was reduced. That was not before McLaren had spent more than £1 million on engine development alone, and had secured no fewer than 10 customers for the GTE car.

'We would like GT Plus as quickly as we can,' says Martin Whitmarsh, CEO of McLaren Racing. 'We took the view that given the GT convergence, why would people buy GTE cars, which are expensive to buy and massively expensive to run? It is pretty crazy really. You can take our GT Sprint, which is cheaper to buy, fractions of the cost to run, and is as quick as any of those GT cars. GTE and Le Mans are very evocative for our customers and we would like to go back there at some stage. We will wait for GT convergence and for 2016 we hope to be there.

'At the moment there are instances where the GT3 car is quicker than a GTE car, but that makes no sense. The fundamental GT3 car can be made a lot quicker without balance of performance. GT tries to be all things to all people, and to an extent that goes against the thoroughbreds. Those who have overtly got cars that are geared to GT cars will suffer greater balance of performance than cars that are having to stretch their performance to reach BoP. We believe that GT is important to our pedigree, important to our brand and we like doing it.'

For the GT3, however, there is work to be done to improve the image, and Whitmarsh agrees. 'The fact is that we are running with gentlemen drivers, we are not going into championships with full professional teams, and we are not going into it as a manufacturer, so we are not putting the money into it that some German manufacturers are,' he says. 'We are learning about developing GT cars, the technology, the championships and the politics of balance of performance, and we still have some way to go. It has been a good start to the process and we have built up the resources within McLaren GT now, and we are focussed and committed to being here for 10-15 years. We have a McLaren GT3 at the moment; hopefully the regulations on GT Plus will be fixed shortly, and we will certainly be entering that. We have the GT Sprint which is a low-cost GT, and I think that will be popular as it is a fantastic car. It can be very quick, we can make it more gentleman friendly, which is part of the learning process, but I think we can also make it better.'

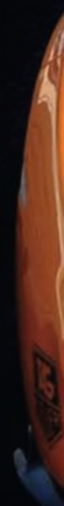
GT3 UNLEASHED

American customers began to ask why the GT3 car, with its air restrictors, was less powerful than the road car. McLaren decided to build the Can-Am version of the car, including an unrestricted engine and lightweight design.

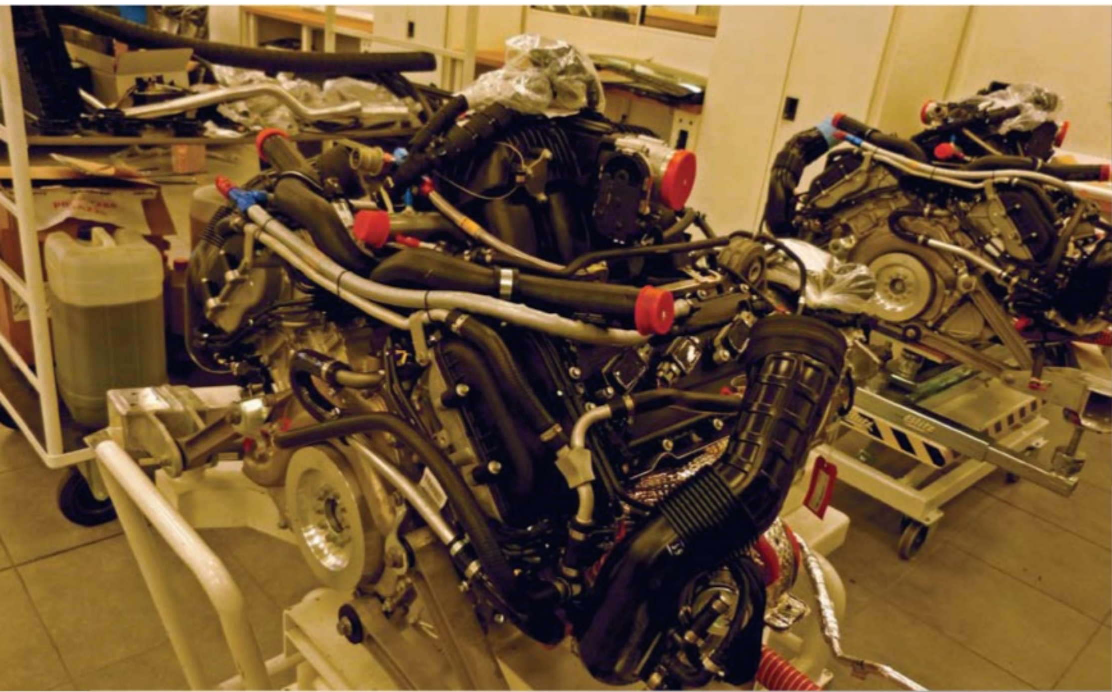
For the European market, McLaren has similarly launched the 12C GT Sprint, a relatively low-cost version of the GT3, and aimed at the track day enthusiast with plans to develop a one-make series if enough are sold. 'There is a lot in the road car that is state of the art, unique and in a way it is a shame that GT3 and GT regulations dumb cars down,' says chief development driver Chris Goodwin. 'There was a desire to showcase what McLaren and the 12C is all about on track. It is a good opportunity to do that because it does retain all that the road car has.'

The 12C has been designed and built by McLaren GT, in close consultation with the team at McLaren Automotive, and retains many of the systems from the road car, including the brake steer and the air brake, while a recalibrated Proactive Chassis Control system can be set to individual driver preference.

'It starts life like a GT3 car, with the same cage and essentially the same fuel tank, but not with the same internals because they are from the road car,' says McLaren GT managing director Andrew Kirkaldy. 'It runs very similar



'There was a desire to showcase what the McLaren 12C is all about on track'



Left: McLaren's 3.8 litre V8 is the only GT3 car with a turbo engine
Above: The lightweight MonoCell chassis is shared with the roadcar
Left bottom: MP4 12C GT Sprint can be yours for £195,000

suspension, and some of the GT3 cooling on it because compared to the road car we needed some extra to be using it at the high end rev range all the time. It has centre lock fixing on the wheels, slick tyres, which are slightly bigger at the front. We then got Chris involved and developed our own adaptive damping. Then we got Bosch involved, and did our own ESP calibration. From a slick point of view, it is really switched on. It controls it very well, but we needed to tone it down a bit.

'We were fortunate in that what we then wanted to do, we had carry over from the GT3. Some elements we still needed to develop, and the car is 40 mm lower. We are in the same bracket as the Ferrari Challenge car. It is £195,000 for a base car, which is high when compared to the Lotus, but is similar to the Lamborghini or Ferrari track day cars.'

Power comes from the M838T, 3.8 litre twin turbo V8 found in the 12C and the 12C Spyder, while power is delivered through a seven-speed twin clutch gearbox. Optimised oil and cooling systems are unique to the track-focussed car.

The 12C GT Sprint is built around the 12C's 75kg carbon fibre MonoCell chassis, but any unnecessary systems or creature comforts have been removed to keep weight to a minimum. The car features a number of components from the GT3 version, including an FIA-approved roll cage, central cooling radiator and digital dash display.

The car comes with a fully adjustable, lightweight composite racing seat fitted with a full six-point harness, an air conditioning system, an integrated fire extinguisher and options available include a carbon rear wing and front splitter, and a lightweight front windscreen.

Adjusting the Proactive Chassis Control was the main thrust of the development work, adapting the car from its production settings to work with a drop in ride height of 40mm, and to work with slick tyres. 'It is incredibly complicated if you haven't done it before, but we have done it for the road car,' says Goodwin. 'We took the pre-existing systems, and tuned them to have the same character around different hardware. We lowered the suspension, put in different springs, different bushes, different tyres.

'You just have to recalibrate the whole matrix of damper stiffnesses to accommodate the damper change. We wanted it to be possible for the amateur track day user to have support from the traction control and ESP if you wanted it, or Andrew could jump in the car, switch it off and drive it like a pure racing car.'

And McLaren has plans to use it as both. 'It doesn't comply to any regulations, but there are championships that would accept it,' concludes Kirkaldy. 'That was the idea behind it. A lot of people in the world just want a track car, and there are people with Lotus and Ferraris that they have just for track use.'

The 12C GT Sprint doesn't comply to any regulations, but there are championships that would accept it

Small steps Big rewards?

When it launched in January, few expected the MR02 to be challenging the opposition as effectively as it has in 2013. Marussia kept the faith

BY SAM COLLINS

On a chilly January morning at the Jerez circuit in southern Spain, the Marussia MR02 was unveiled to the world for the first time. Few people expected much – indeed its closest rival, Caterham, had decided not to develop a new car for 2013, instead choosing to focus on the 2014 season. It did not see Marussia as a threat. It was wrong.

The Marussia team started life as Manor Grand Prix, an offshoot of the British Manor Motorsport team which specialises in the junior open wheel categories. It contested the 2010 season as Virgin Racing, named after the British business group, then its major commercial partner. Wirth Research designed the car using its all-CFD mentality, but poor results and very public criticism from some of the team's drivers saw the relationship come to an end in 2011. By that time the Russian group behind fledgling sportscar company Marussia had become involved with the team, but even by 2013 the team's budget was still modest.

However, the MR02 was the first car the team developed using a conventional aerodynamic development approach.

'It was a definite evolution of last year's car, which was the first we had designed in-house,' explains Marussia chief engineer Dave Greenwood. 'Aerodynamically speaking the car was a continuation from last year due to the stable regulations. The MR01 was primarily a CFD-only design, so it was only the mid- to late-season updates that were wind tunnel-based. MR02 is the first car we have done fully in the wind tunnel.'

The team does not have its own wind tunnel, so in order to develop the MR02 it used its partnership with McLaren Applied Technologies, which included access to the 50 per cent scale wind tunnel.

'Although they are similar, the two cars used separate 50 per cent scale models,' says Greenwood. 'But, we did start the 2013 season with the same front and rear wings as we used on the MR01. We left it as late as possible so there is interchangeability between nose boxes, for example.'

'To a certain extent we have thrown most of our weight behind 2014 – and quite a long time ago'

A key area in the aerodynamic development of the MR02 was improving cooling efficiency, thereby improving air flow over the rear of the car. This is clearly evident in the new sidepod design, and the car features a more effective Coanda exhaust than those tried on the MR01.

'Our exploration with exhausts began mid-season last year and was a feature of the car from the beginning with MR02,' Greenwood explains. 'Over the winter we worked really hard with Cosworth to catch up in terms of engine mapping. It's no secret that the top guys, mostly the Renault runners, have been able to exploit the gas flow coming out of the tailpipe to get more downforce. After Cosworth did some running on the dyno we looked at the impact of it on the chassis, as it is not just a case of using the gas to make downforce; the way you do it fundamentally changes the braking balance of the car.'

These blown diffusers are now fitted to every car on the 2013 F1 grid and use the exhaust gasses to seal off the outer edges of the rear floor, preventing the messy vortex from the rear wheel from entering the diffuser area. It has been an area of focus for many teams on the grid, including Marussia.

'It's hard to spot the changes we have made during the season as they are very subtle, but in some areas of the exhaust exit we got up to five iterations on the MR02; there were two or three iterations of the pipes themselves, and the furniture down on the floor has also had a few iterations,' says Greenwood. 'If we had carried on there would be even more. Even now we have very recently done some full-scale work on the system. More and more these days you put instrumentation on the full scale car and do evaluation that way.'

But the MR02's aerodynamic package is not the major focus for the team. According to Greenwood, 'we stopped running the car in the wind tunnel quite a long time ago so we could use the available time for the 2014 car. The last aerodynamic upgrade on the MR02 was mid-season, around the time of the British Grand Prix. To a certain extent we have thrown most of our weight behind 2014 – and quite a long time ago – but that's not to say we've not had small developments which have come recently. They've been extremely cost-effective developments, which has helped, and the financial burden of 2014 is big as well.'

Mechanically the MR02 is very similar to the MR01, at least on paper. It retains the Cosworth CA engine (see P60) and a similar suspension layout, but a lot of work has been done under the skin – and, indeed, between the skins – to improve the overall package. One of the major differences is the use of KERS, a first for the team.

'We took proven technology from Williams and that helped us a lot. They told us how to mount it, how to cool it, and all of that stuff,' Greenwood continues. 'Then it was up to us to integrate it with the car. Overall it's been a strong success, totally reliable; there were very few teething issues and nothing that came close to stopping the car in testing.'

As part of installing the hybrid system, the chassis weight needed to be reduced while maintaining stiffness and meeting the demands of the mandatory FIA crash tests. This saw the Marussia engineers use some new techniques in the composites department.

'John McQuilliam, the chief designer, set himself an ambitious target to get weight out of the chassis and he does that every year. He made a good step for this year's car, and looking at next year's car he is going to make an even bigger step. Most of the manufacturing work on the first 2014 chassis is done already,' Greenwood reveals. 'The MR02 is a completely different chassis to MR01: it's similar in terms of cockpit layout and front suspension pick up points, but the laminate and overall layups are very different.'

While Marussia has largely stopped its wind tunnel programme for the MR02, updates continue in other areas which still manage to lead to improvements in the car's aerodynamic performance.

Performance gains can be made 'basically, by judging small mechanical upgrades that can maybe help optimise the aerodynamics of the car – by that, obviously, I mean suspension to allow you to run in the place and the track to get the best downforce from the map you've got,' Greenwood explains. 'So we've worked a lot on those small parts which can give you gains for not very much money and also not very much lead time which is good.'

The Russian team has worked with Penske to develop an interlinked suspension, previously only the preserve of the very top teams

Indeed, while the overall suspension design and concept was carried over from the MR01, it has been an area of substantial work. 'The front suspension was largely carried over from the MR01, both inboard and outboard; that was because we felt that there was not anything fundamentally wrong with MR01 in terms of suspension – it performed reasonably well on the seven-post rig. We never had comments back from the drivers either that were suspension related,' he continues.

Overall, the suspension is fairly conventional at face value, with twin unequal length carbon fibre wishbones. The front dampers are pushrod actuated, with the rears a pullrod layout.

'We've worked a lot on those small parts which can give you gains for not very much money'

However, this does not mean that the suspension is identical to the MR01: there have been many detail changes through the year, and even before the car was launched.

'We did do some work on the front, to solve an inherent balance issue we found that was causing mid-corner understeer, so that was a small change we made. The rear suspension was slightly repackaged, but it's not vastly different. Just lots of small changes and constant changes,' Greenwood reveals.

TYRE DILEMMA

While some teams have made major changes to their suspension to cope with the Pirelli tyres Marussia has not.

'The tyres is another area where we have worked hard this year; it is difficult for a small team like ours to make wholesale geometry changes as it would be too expensive, so that tends to be done on a year-to-year basis. But you can definitely find ways to use your tyres. It's more critical on these than on previous F1 tyres to get them in the optimal working window.'

In fact, the focus for Marussia is a suprising one: it has worked with partner Penske to introduce hydraulically interlinked suspension, something that was the preserve of only the biggest teams a couple of years ago.

'The big area we are all working on is the interlinked suspension; that's something we have been developing through 2013. We have also been looking at things in the basic suspension layout that allow you to improve the way you are running in the aero map. We have a strong relationship with Penske; some of the parts on the interlinked suspension have been design by them in conjunction with us.

'Normal work, like tuning your damper curves on the rig, we do in-house, but some of the overall design work of new parts we do in partnership with them. It's a situation where we come up with the concept and they do the detail design work on it. Our system does not not employ a mechanical springing medium to give us heavy stiffness; we use something a bit more compact

The Marussia MR02 used the same front and rear wings as the MR01 to speed up development, but all teams have worked on the use of exhaust gasses to increase downforce

and a bit lighter than that, but for now that's still a secret,' Greenwood smiles.

BOXING CLEVER

Like all cars built by the team to date, the MR02 uses an Xtrac transmission, and this too has been modified to increase the installation stiffness of the rear suspension. Initially the 1044 gearbox and the Cosworth CA were introduced as part of the FIA's low-cost F1 team drive of 2010, but the concept did not last long. But Xtrac's 'batch-produced' gearbox with common parts did offer teams significant cost savings: it features a longitudinal layout, commonly seen in F1 gearboxes, with the gear cluster forward of the differential to ensure good vehicle weight distribution.

Drive from the engine enters via the longitudinal layshaft, directly below the mainshaft, to allow for the lowest possible crank height. Together, these shafts carry the mating pairs of seven forward ratios. Drive is then transferred from the rear of the mainshaft via a pair of bevel gears to a transverse idler shaft. This is needed to lift the drive up to the hub height of the rear wheels and meshes with the final drive. The differential is an active hydraulic type.

'There is a strong involvement from our guys with the transmission, but the new casing was largely done to help with stiffness of the suspension. Not just vertical stiffness, but also toe stiffness, camber stiffness... There is a lot of work to look at those areas and to improve those areas,' Greenwood explains.

'We worked out what we wanted to achieve and then Xtrac went away and worked on it, came back and compared FE results. So it's a real collaboration, but with them doing the lion's share of the work. The internals have evolved from the 2010 Xtrac 1044 transmission, and a lot of work has been done to lighten them.

'Some areas have been improved in performance terms too, notably the differential,' he continued. 'While the overall architecture is similar is to the original box it is not the same.'

Overall, the MR02 has been a huge step forward for Marussia. Using the circuit at Suzuka in Japan as a reference, the MR02 is around one second a lap faster on average than the MR01. Some of this is likely due to the tyres, but since the failures at Silverstone the Pirelli rubber has been very similar to the tyres used in 2012. Comparatively speaking, Caterham has only gained around two-tenths of a second year on year, but then it did not develop a new car for the 2013 season.

'Obviously, as anyone else would say, the main advantage has come in aerodynamics – better correlation in the wind tunnel – and perhaps slightly more creativity in that area. That's really where most of the lap time has come, coupled with improvements in the mechanical installation,' Greenwood explains.

For Marussia the target for the 2013 season is clear: finish 10th in the Constructors' Championship, something that brings with it tens of millions of dollars in prize money. A 12th-place finish in the Malaysian Grand Prix put the team 10th, but a better finish from Caterham would cost Marussia its place, and a lot of money.

'What we have to do trackside is get every little last bit of pace out of the car, so if you get one of those races where everyone ahead falls out, we are ahead of the Caterhams,' Greenwood admits.

But with the big steps taken in the MR02's performance relative to the 2013 Caterham, the Leafield-based team may regret the day that they underestimated the Russian-branded, English-based team.

The MR02 is around one second a lap faster around Japan's Suzuka Circuit than the MR01

TECH SPEC
Marussia MR02

Engine: Cosworth CA 2.4 litre V8 N/A

KERS: Williams Advanced Engineering, battery electric, Kokam Lithium based cells, single brushless DC motor generator unit.

Chassis material: Carbon

Bodywork material: Carbon

Front suspension: Carbon fibre with carbon flexure joints

Rear suspension: Carbon fibre

Dampers: Penske

Steering: Marussia F1 Team designed hydraulic PAS

Gearbox: Aluminium construction with 7-speed Xtrac longitudinally mounted internals

Clutch: AP Racing

Discs: Hitco Carbon - Carbon

Callipers: AP Racing

Pads: Hitco Carbon - Carbon

Cooling system: Marussia F1 Team

Cockpit instrumentation: MES SECU

Seat belts: Willans six point harness

Steering wheel: Marussia F1 Team design with MES electronics

Driver seat: Anatomically formed carbon composite

Extinguisher system: FEV FIA approved system

Wheels: BBS

Fuel cell: ATL

Battery: Braille

Fuel: BP Castrol

Lubricants: BP Castrol

Front Track: 1800mm
Rear Track: 1800mm

Wheelbase: 3400mm

Keeping it cool

Formula 1's 2014 powertrain regulations have given designers the length of the pit lane something of a packaging headache

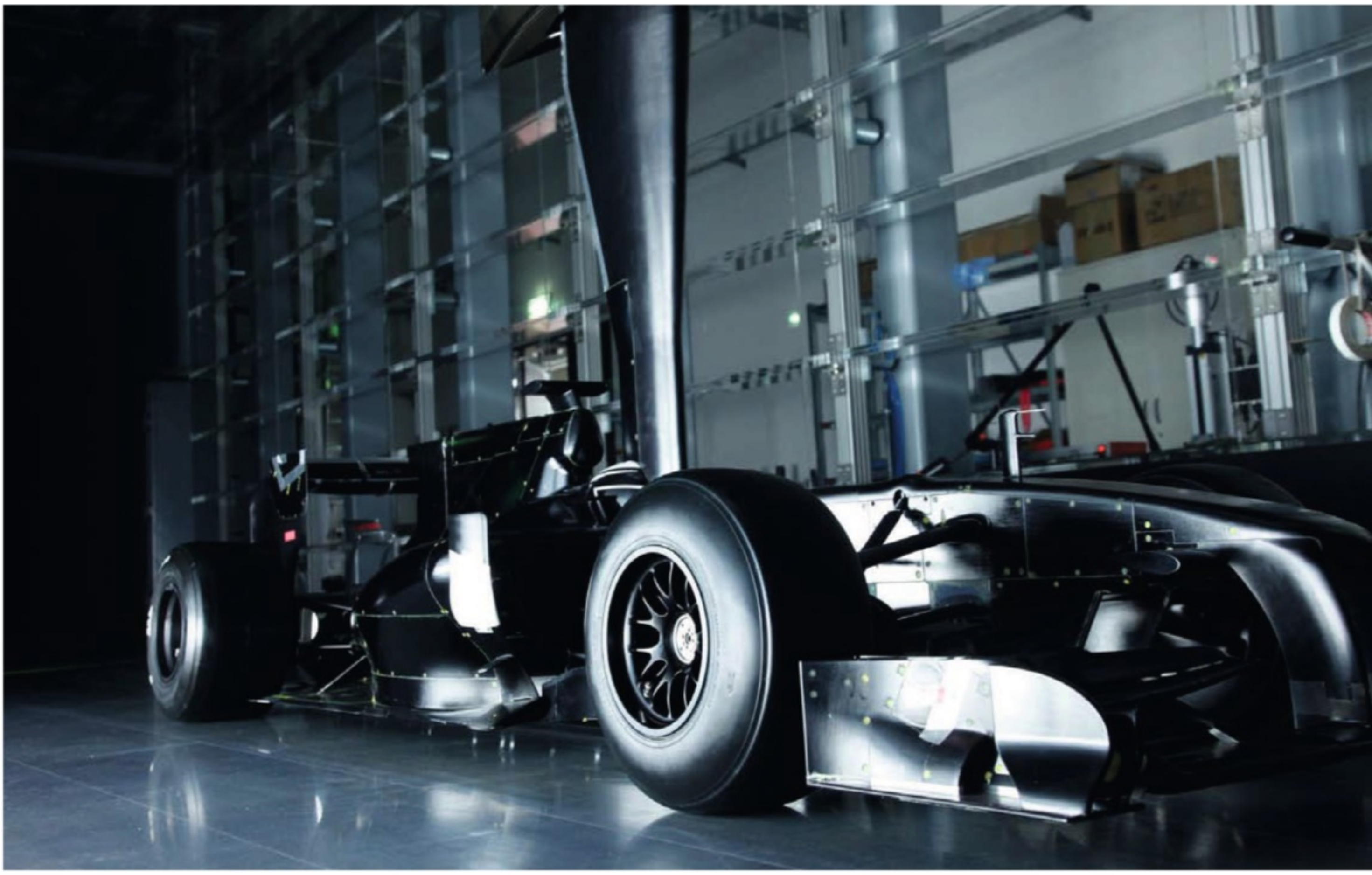
Cooling aids such as the 'ears' featured on the Lotus at the Australian Grand Prix in 2013 are likely to feature prominently

BY SAM COLLINS

The 2014 season will see a year of significant change in top level motor racing, not least in Formula 1. The arrival of the innovative new power units has created a significant workload for the teams, and that is not limited merely to the powertrain department. On paper, a 1.6 litre V6 should be easier to package in a car than a 2.4 litre V8, but it is far more complex a task than it first appears, with many competing factors to take into account.

'It is about power delivery, fuel consumption and reliability in 2014,' Adrian Newey, chief technical officer at Red Bull explains. 'Of course, most of that is out of our control as it is in the hands of Renault. Where we will be working hard is packaging that engine, especially with all of the electrical parts; it's a huge change. The cooling in particular is a challenge, the internal combustion engine itself needs slightly less cooling, but you also have a turbocharger and charge air cooling, and on top of that the electrical side needs a lot of cooling. So there is a big increase in cooling demand on the new cars.'

'Where we will be working hard is packaging that engine, especially with all of the electrical parts; it's a huge change.'



Next year's aero testing is heavily restricted, including a limitation of wind tunnel time and scale; 60 per cent models are the maximum allowed

This extra demand is not as straightforward as fitting the car with larger radiator ducts, as some of the components – such as the single turbocharger – are not well-positioned for that kind of cooling. Additional ducting is therefore likely to appear on the engine cover, perhaps similar in appearance to the gearbox oil cooler ducting on the Toyota TF110, or the rear wing stalling 'ears' seen on the 2013 Lotus and Sauber. Larger sidepods also seem highly likely, with the addition of an intercooler to the current oil and water radiators.

'The biggest thing is the cooling challenge,' explains Caterham technical director Mark Smith. 'That's probably the thing that, I imagine, has most people up and down the pit lane scratching their heads. It's reasonably easy to come up with a solution that will cool, but to come up with a solution that will cool and give you the optimum aerodynamic performance is the challenge.

'The charged air cooler, for cooling the air from the turbo before it goes into the engine, will, on all of the installations, be quite significant. Physically, the size of the thing will dictate the packaging of everybody's cooling systems.'

NO MORE BLOWN DIFFUSERS

With a severe reduction of fuel consumption being introduced, including a fuel flow limit, there will be significant pressure on aerodynamic departments to reduce drag and increase overall efficiency. In addition, the rules require cars to run a single exhaust exit mounted higher in the car, producing a much lower energy exhaust plume, ending the current blown diffusers. The new regulations force teams to use a single tailpipe which must exit 170-185mm behind the rear axle line and 350-500mm above the floor. The end portion of the pipe must be angled upwards, and bodywork is banned in the area behind to prevent teams from channeling the flow in a beneficial way, leading to a notable cut in downforce.

Alongside the aerodynamic changes – which are a direct result of the introduction of the new power units – there are also a significant number of new rules surrounding the cars' bodywork, as Newey reveals with obvious dissatisfaction: 'The changes coming in give us a narrower front wing, low nose and we lose the beam wing. That's a short-term challenge, but in reality it's just further restrictions. I think it's a shame that year on year we just have more restrictions.'

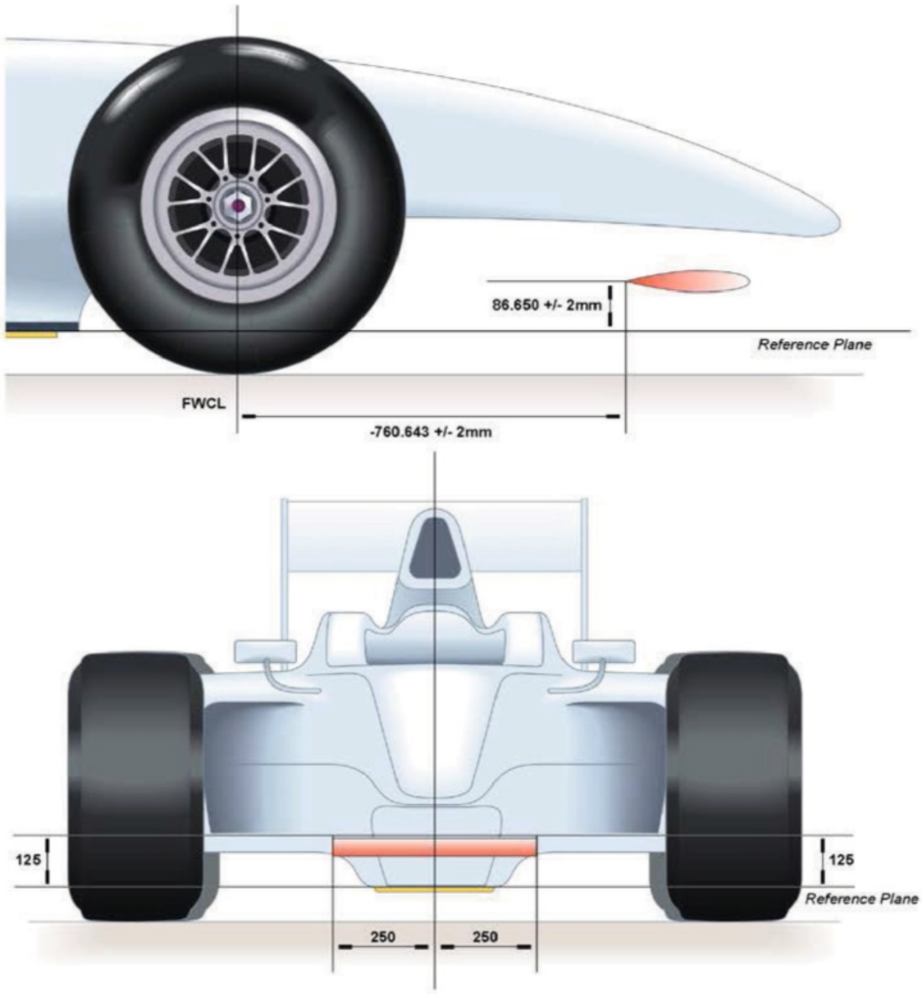
In addition to the removal of the lower beam wing, the main flap of the rear wing will be slightly shallower. The front wing will also change, becoming 150mm narrower, from 1800mm to 1650mm.

Newey also reportedly believes that the new regulations have not fully resolved the issue of ugly looking cars, stating that the new Red Bull is 'ugly' because the new aerodynamic rules sent designers down the path of penning a hook nose.

HOOK, OR SINKER?

Indeed, the height of the nose will be reduced significantly, from 550mm in 2013 down to 185mm in 2014. But the 'hook nose' thoery is not a view held by all. Ross Brawn, Mercedes team principal, claims his team's 2014 design does not suffer from the issue raised by his long-time rival. 'I'm not sure what Adrian is talking about,' Brawn says. 'Our nose looks normal – maybe we have missed something!'

'It's reasonably easy to come up with a solution that will cool, but to come up with a solution that will cool and give you the optimum aerodynamic performance is the challenge'



Leading teams are divided over whether or not the new low nose will lead to a 'hook' design or not

Other senior engineers feel that it is not the nose regulations that will make the cars appear different; rather it will be the cooling demands of the new power units. 'Will they look significantly different to people who don't follow the subtleties of the sport? Perhaps not,' Smith contests.

'I think we're trying to resist having to make significant changes that will affect the external appearance of the car because of what we're trying to do aerodynamically, but we're fighting a little bit of a losing battle. I wouldn't be surprised if we did end up with a few solutions that are a bit different because the challenge of just packaging the size of cooling systems that are on the car is quite extreme.'

Marussia's chief engineer Dave Greenwood echoes these thoughts. 'It's not going to be obvious from the regulations where the cars will not look quite like what we are used to. I'm not going to say it's ugly, but they certainly look different! You know when you first see them it will be a surprise, but after the first few races you won't notice.'

INCREASED RESTRICTIONS

The difficulty of developing a car to the new regulations is compounded somewhat by increased restrictions on tools used to develop the cars.

Wind tunnel testing has been restricted to a maximum of 80 runs per week and a maximum of 60 hours of tunnel occupancy, with only 30 hours of 'wind on time'. No models larger than 60 per cent scale are permitted to be used, and the maximum airspeed in the tunnel is 50m/s. This seems to outlaw the Windshear tunnel in North Carolina, which some teams used for full-scale testing in past years. This could be open to interpretation, as it is arguable that the actual car is not a 'model' at all. CFD testing is restricted to 30 Teraflops per week.

Crucially, the new aerodynamic testing restrictions do not apply to tests purely aimed at developing components associated with cooling, or the operation of the power unit. This allows teams to conduct additional testing restricted to the area downstream of the engine air intake duct, passing through the engine and finishing at the exit of the exhaust tailpipes, provided that there is no direct or indirect measurement of aerodynamic force during the test.

Straightline aerodynamic testing, recently in the news for the wrong reasons, has been outlawed, possibly as a reaction to the accident that eventually killed Maria de Villota. From the start of 2014, Formula 1 teams can only test their cars at FIA Category 1 (and Category 1T) circuits, and aside from a couple of 100km 'filming' days the only running this will consist of are four in-season group tests, as well as the three pre-season group tests.

Juggling the development of an all-new car concept with an ongoing championship season has also been a consideration for many on the grid, with the differences between positions in the Constructors' Championship at the end of the season worth millions of dollars.

'There are certain things you can learn this year which will help you next year, but a lot of the major bits are not carry-over at all,' admits Toro Rosso technical director James Key. 'It really is a balancing act of trying to efficiently do what you can in the latter half of this season, for this year, and make sure you're not losing focus on next year. It's always tricky because when these regulations come along, so does an opportunity to take a step forward, but there will be a risk of damaging your previous year.'

It is a challenge many of the midfield teams struggled with in the closing races of the season, and it resulted in a number of teams losing positions in the Constructors' Championship. The result of all the work will be seen in late January at the Jerez Circuit in Spain, a test one engineer told *Racecar Engineering* that he was particularly looking forward to. 'I think Jerez will be interesting at the first test. There will be lots of fires. I wonder how many cars will be able to run on all of the days...'

'It's always tricky because when these regulations come along, so does an opportunity to take a step forward'

The world's best-known mechanic

Nigel Stepney looks back on a long career in Formula 1, and the scandal that drove him to sports cars

BY ANDREW COTTON

In the world of motorsport, there are few mechanics who stand out as household names. Nigel Stepney is one. In his time working for Lotus, Benetton, Ferrari and Shadow, the Briton worked under some of the most influential designers in the history of Formula 1, including Colin Chapman and John Barnard, and with some of the most influential drivers of the modern era, including Ayrton Senna and Michael Schumacher. Since leaving Formula 1, Stepney has won another world championship title in GT racing with the JRM Nissan team.

Yet it was his departure from Ferrari that catapulted his name into the international spotlight as he was accused of passing secret information from Ferrari to McLaren in 2007, for which McLaren was heavily fined. The FIA issued a statement warning any against team from employing Stepney in the future. It was a fall from grace that was public, the result of actions that the 54-year-old continues to deny.

Stepping into the arena of motorsport was almost accidental for Stepney, as he left school intending to be a sports teacher. The local Broadspeed company recruited two school leavers per year to its garage, and it was here that the young Stepney began his motor racing career. 'They had everything there, from the normal servicing of road cars to the racing cars,' says Stepney. 'We were running Dolomite Sprints in the British Touring Car Championship with Andy Rouse. It was a good base because they did everything there, from body panels to rolling road, engine

Main picture: Jean Todt, Ross Brawn, NIgel Stepney and Michael Schumacher turned Ferrari into a title-winning outfit
Top: Starting the F93A on a cold day was a baptism of fire for Stepney as he began his career at Ferrari
Above: Elio de Angelis worked with Stepney at Shadow and Lotus before moving to Brabham

dyno, gearboxes, fabrication and machining. It was all in-house. As an apprentice, you went around all of those departments, and you went racing.'

Local team Shadow split with Arrows in 1978, and the separation opened up job opportunities. At the age of 21, Stepney was interviewed by Jo Ramirez and was offered a job as number two mechanic to Clay Reggazoni, newly signed to the team. His first race was the Swedish Grand Prix, where Brabham turned up with the BT46, dubbed the 'fan car'. 'That was my baptism,' says Stepney. 'It was an eye-opener. You still had those big technical differences between the cars and the teams. Shadow was a small, independent team with a Ford Cosworth engine, but you could still compete. At the end of the season I was tied up with Elio de Angelis. We were fourth at Watkins Glen in 1979, beating the Ferraris, which was mega.'

Mid-way through the year, Stepney was put in charge of preparing the spare car in readiness should anything happen to the team's lead cars. The spare was built up in the workshop and then dismantled so that at the intercontinental races two mechanics could build up the chassis in just four hours.

The turning point came when a mechanic on one of the race cars forgot to tighten the plugs properly, causing three to vacate the engine, and the fourth to get stuck in it. The T-car was rolled out, and declared to be better than the race car.

'That's how I got my break,' said Stepney. 'I took over running the race car with de Angelis.' The Italian moved from Shadow to Lotus, and took Stepney with him in 1982, giving both men the opportunity to work with legendary Lotus engineer Colin Chapman before his death that December.

The Briton worked on the Lotus 88, a car that had a softly sprung chassis in which the driver sat, and a stiffly sprung second chassis. It never raced, as rival teams protested its inclusion in grands prix. 'It was so political: we were going to races, building them, and getting banned. Lotus was a bigger team, more resources, but it wasn't the top in terms of technology, but active started there, and it was an interesting place to learn. You weren't following, you were leading.'

Although Stepney wasn't involved in the creation of these technologies, he was responsible for putting the car together at a time when reliability was as important as speed.

'When Colin died, the car was horrendous, but with Gerard Ducarouge [who was brought in to stabilise Lotus after Chapman's death], we calmed things down, went back a year on the chassis and started rebuilding. Ducarouge wouldn't experiment. We had a very good engine, good drivers, but you were never going to achieve that ultimate goal because you weren't taking that calculated risk, so we were limited.'

Stepney worked with de Angelis at Lotus, but was controversially switched to Senna's car by the team. It was a move that hardly eased the atmosphere in the team, with de Angelis convinced that

The Broadspeed Jaguars are still Stepney's favourite cars

Senna was receiving preferential treatment. At the end of the year, de Angelis left to go to Brabham, and invited Stepney to go with him. Stepney, already told by Brabham that they didn't want him, turned de Angelis down and stayed with Senna at Lotus.

'De Angelis raised his level and was very quick, but Senna was just a different level in terms of how he could perform at that level for a longer period of time in that he didn't destroy his tyres,' says Stepney. '[De Angelis] was very much harder on the tyres.'

When the Brazilian moved to McLaren in 1988, he asked Stepney to go with him. Stepney didn't expect to work with Senna as his mechanic, but also didn't expect what Ron Dennis offered him; a job working with the test team in Japan. He turned it down and in 1988 joined Benetton.

'It was time to move,' says Stepney. 'I went as chief mechanic, which I was never going to be at Lotus. That's when I met John Barnard, and he was another of the top people. Rory Byrne was there, Pat Symonds and Peter Collins. Flavio [Briatore] was incredibly switched on. He knew how to run a business, he knew politics, and he had the resources that he could put into the right areas.'

Barnard worked out of a separate office, which meant – according to Stepney – that the team lacked cohesion.

Barnard, however, was a major strength in the team. 'Some of these people can come along in a tense situation, and calm it down. He can come along when you are deep in the shit, and put logic into where other people were missing. Some of what he was doing was well ahead of its time; he did the carbon chassis at McLaren, carbon gearboxes, and those were stressing times for Briatore. You get an innovator, but the risks are attached. Most of the stuff that was on the car in the late 1990s, it was innovated there. All people did was improve those basic things.'

After a brief spell with Nelson Piquet's fledgling F3000 team, which meant a step into management, Stepney moved to Ferrari in 1993.

'Everything was there; it wasn't all being pulled in one direction,' says Stepney. 'Barnard had his technical office in the UK, and I was sent there as what was perceived as his spy at the time. When I walked into Harvey Postlethwaite's office he had his feet up on the table and he looked around his paper, said: "Ah, you're Barnard's man," and that was it.

'Every office where you had a FIAT delegate, they would walk in, read the newspapers every morning, and no one was really doing anything. They were going through the motions. I joined to manage systems and put mechanical parts in, and make sure they were looked after, building the cars how you wanted them built, and making sure no one was interfering with them.

'The first test I went to was half an active car, the F93A. We went to an airfield to do some straight-line testing with this thing and it was freezing cold. We arrived, the canopy was up, the truck looked nice, but the hydraulic actuator was so cold that the seals went and the fluid just flew out because it was freezing cold. We needed a heater, a generator. There wasn't one. You open the truck and it was horrendous. Dirty, filthy, junk, crap. We brought another truck out which had to stop to be washed before it could come to the circuit. We tried to fire up the generator, and it didn't work. Then the third truck comes from Maranello, no generator. We lost all day just trying to get the generator to work!'

The language barrier did not help matters – Modena has its own dialect, and Stepney spent a year trying to work it out. Slowly things started to improve, and as Jean Todt and Schumacher arrived, the processes were being put into place.

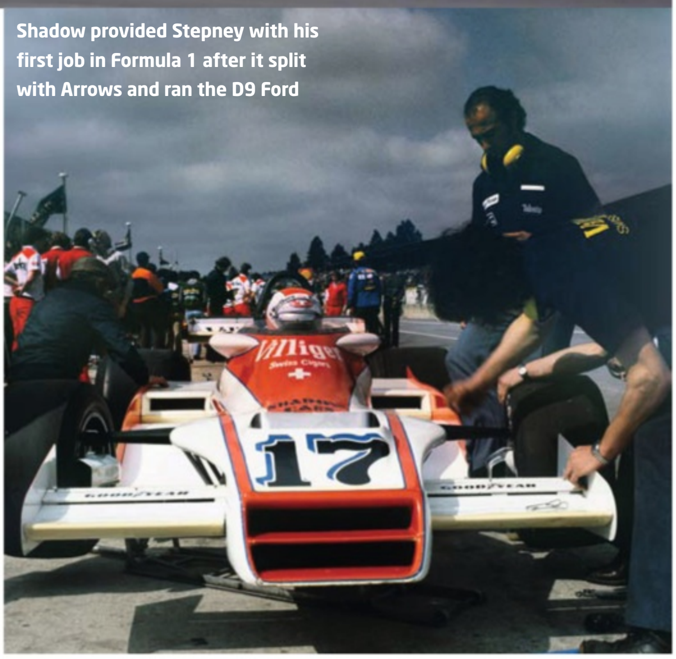
Previously, an order for two examples of an experimental part would see 20 delivered. Barnard left after an overhaul of the design offices in Maranello, and everything was brought in-house under Todt and Ross Brawn, who was overseeing a capable technical department.

At the start of the 2007 season, the new Ferrari had a moveable floor and a separator on the rear wing, both visible to rival teams, but at the opening round in Melbourne, Stepney had an informal conversation with former colleague Mike Coughlan, then at McLaren.

According to a letter from Ron Dennis to Italian motorsport authority president Luigi Macaluso, 'In March 2007, Mr Stepney of Ferrari contacted Mr Coughlan and informed him about two aspects of the Ferrari car which he regarded being in breach of FIA regulations.

'Specifically, he told Mr Coughlan about a floor attachment mechanism and a rear wing separator, both

'Flavio knew how to run a business, he knew politics, and he had the resources that he could put into the right areas.'



Shadow provided Stepney with his first job in Formula 1 after it split with Arrows and ran the D9 Ford

of which could be and were seen on the Ferrari car prior to the Australian Grand Prix. Mr Coughlan immediately told McLaren's senior management about Mr Stepney's allegations. McLaren took steps to confirm whether the allegations were true, and we concluded that they were. Accordingly we reported these two matters to the FIA, adopting the customary practice of asking the FIA Technical Department for their opinion.

'As regards the rear wing separator, the FIA subsequently ruled that this was compliant with the Technical Regulations. However, the FIA ruled that this floor device was illegal. You will appreciate the significance of this. As far as we are aware, Ferrari ran their cars with this illegal device at the Australian Grand Prix, which they won. In the interests of the sport, McLaren chose not to protest the result of the Australian Grand Prix even though it seems clear that Ferrari had an illegal competitive advantage. Ferrari only withdrew the floor device after it was confirmed to be illegal by the FIA.'

Stepney adds: 'I like to try to win on a fair basis. Making that basis, where do you draw the line being within the boundaries of the regulations and interpretations of those limits? And, if you are going to overstep those marks until you get caught, and when you get caught all you get is a slap on the wrists, then I think some of it goes beyond the limitations. When I was there I disagreed with something that was going on within Ferrari. Schumacher had gone, Brawn had gone, Rory was still there. I felt comfortable under Ross; like Barnard he would take on the responsibility.

'When he went I could have stepped into another position had I wanted to, but I felt that it was starting to go beyond some limits myself and I didn't feel comfortable with it, and that is when, because I disagreed, things started to happen.'

Although discussions took place in March, it was later in the year – when Stepney was accused of passing more confidential information regarding Ferrari and its working practices to Coughlan – that legal proceedings were brought. 'I discussed something and it a little bit got out of control,' says Stepney. 'As far as information passing on, when they showed me the document, I hadn't seen 90 per cent of the information in it.

'I went against the team, and yes I disagreed with something that was going on. I spoke to Mike off the record, which was probably wrong at the time. I thought it wasn't correct, and for sure I was wrong to discuss it, but winning until you get stopped was not the correct way, I thought. I went against the grain.'

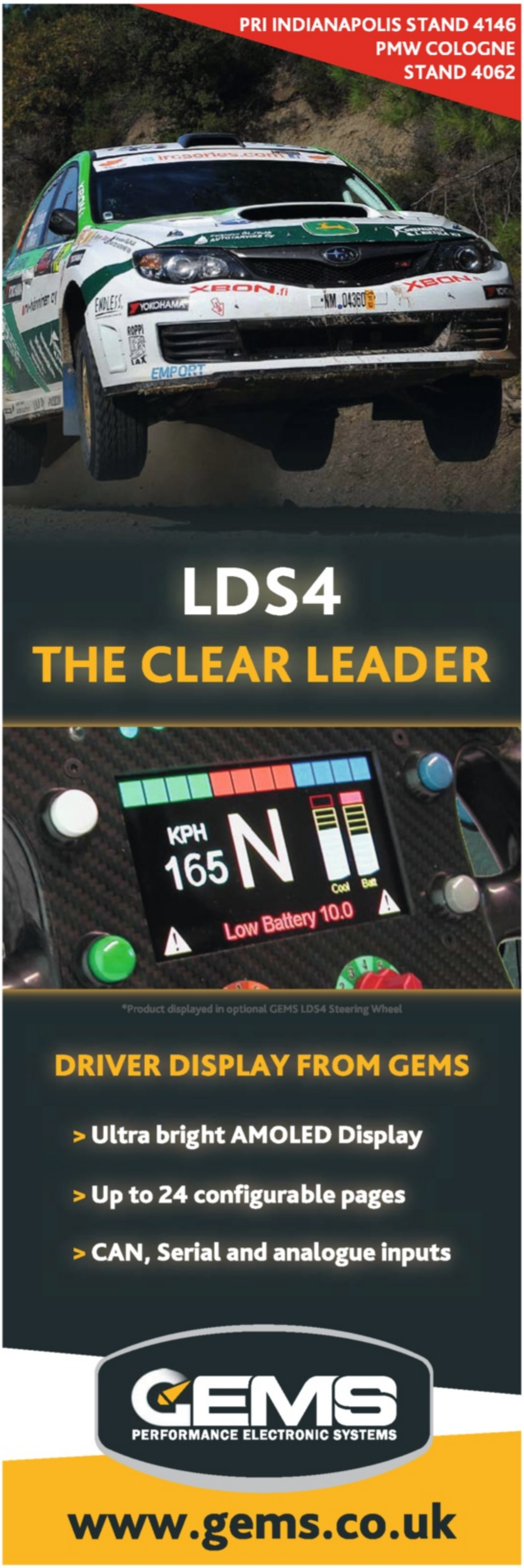
Stepney was fined, and received a suspended jail sentence, but the FIA warned against employing him again. 'I think six months later Mosley retracted that statement, and said that there was more behind the scenes than meets the eye,' says Stepney. 'I also have a letter that shows I got a job offer from the FIA. I refused.'

NEW HORIZONS

Instead, he found a home in sports car racing, with Gigawave running the Aston Martin DBR9. Through results there, the team landed the development role of the Nissan GTR. When the team stopped, the owner of tuning company Sumo Power, James Rumsey, bought two cars and ran them, first as Sumo Racing, and today as JRM, retaining Stepney's services. He ran a Honda HPD at Le Mans under JRM in 2012, and despite missing the event this year, says that there is no better place for a manufacturer to be.

'The only way forward for manufacturers and for designers is LMP1,' says Stepney. 'I think Adrian Newey and people like that would relish the opportunity to participate in Le Mans; it wouldn't surprise me if Red Bull stopped Formula 1 and went to do Le Mans at some point. It must be on Adrian's radar. He is a clever guy, has a lot more freedom. Blown diffusers were thrown out of Formula 1 and have finished up here. Formula 1 is very clinical now. Tyre management is across all forms now. Pure performance now doesn't exist. LMP1 is going in the right direction, calorific value of a quantity of energy. You can only do petrol and diesel because it is hard enough matching the calorific value out of those two without the other elements. It needs manufacturers in there.'

'The only way forward for manufacturers and for designers is LMP1'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noun
the ability or strength to continue or last, especially despite fatigue, stress, or other adverse conditions;
• the capacity of something to last or to withstand wear and tear.
ORIGIN late 15th cent. (in the sense [continued existence, ability to last]; formerly also as indurance): from Old French, from endurer 'make hard' (see ENDURE).
Goodridge fluid transfer systems,
built to last lap after lap,
race after race
Push the Limits
Qatar
M-SPORT
GOODRIDGE
OFFICIAL TEAM PARTNER
ASTON MARTIN RACING
OFFICIAL SUPPLIER
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A bright lite future

As rallycross racing's appeal grows in Europe and the US, a new vehicle and series have been created to develop young drivers

BY DON TAYLOR

Rallycross is the racing sport of the future, and the Supercar Lites cars are to become the series' standard training equipment for aspiring drivers.

At least, that's the way it sounds when listening to the energetic Andreas Eriksson, founder of the Supercar Lites cars, CEO of OlsbergsMSE, and team owner with Supercars in both the Global RallyCross (GRC) and the European Rallycross Championship (ERC) series.

With the growing interest of auto manufacturers in rallycross, and their support of major programs in the series, Eriksson saw the need to develop the future stars to fill those seats. And he saw a way to help those future stars to develop by providing 'a cheaper to run, but still fast and extreme car, in which to learn the right way to drive 4WD. The OMSE Supercar Lite is specially designed for that, and now my vision is working in real life.'

For those readers not familiar with Andreas Eriksson, he is a former Swedish rally champion and WRC driver who has operated his rally car business in Sweden for many years, first as MSE (Motor Sport Evolution), and since 2009 as OlsbergsMSE, or OMSE, reflecting his partnership with the Swedish industrial company Olsbergs Group, in Nynashamn, south of Stockholm. Eriksson knows all about the building, developing, and driving of rally cars, and now has additional resources.

Since July of this year, a series for his cars has been up and running as a support event for the Supercars in the America-based GRC series. That venture has already produced exciting racing, with exposure in the internationally broadcast ESPN X Games in Los Angeles in August.

Eriksson has signed up young, aspiring drivers for his first run of 10 spec racers, including a 15-year-old 'veteran' of American off-road racing. These are drivers who may have had visions of climbing the ladder in road racing, or in the oval track world, but who now see the popularity of rallycross racing increasing on both sides of the Atlantic.

Participating in such a format makes perfect sense to them, and it does to the next generation of fans. In traditional racing formats one must wait hours – days, even – to see who wins; rallycross heat winners are determined in minutes. That's critical for holding the attention of the digital generation, as is providing intense side-by-side action of the sort commonly seen in rallycross, a sport many of its fans compare to a video game brought to life.

It's small wonder that the sport has attracted interest from drinks companies as major sponsors.

For those wanting to learn how to compete in the top level of rallycross, Supercars, Eriksson felt that there were no suitable options in the US. Learning in a Supercar is prohibitively expensive and he sought change.

Eriksson's objectives for the clean-sheet-of-paper car design were clear: to closely match the handing properties of the Supercars while lowering the power and cost. Making them spec cars would prevent deep pockets from buying more speed. The focus was to be on the driver learning experience.

From the beginning, Eriksson understood fundamentally that the cars had to be all-wheel drive, and have braking and suspension systems with the Supercar's feeling and response. To help design and tool up the cars for production, he enlisted another

For aspiring racers, learning in a Supercar is prohibitively expensive

partner, Avitas. The Turkish company, perhaps best known as an automotive parts supplier, had produced the composite body panels for Eriksson's Supercars.

'I worked with Avitas on other projects earlier; they are great and fun to work with,' he explains. 'They were building a low level, 2WD car, "Control 2" for Turkey, and asked me for advice and assistance to develop that car. I looked at it and helped them finish it, but decided to do a completely new design incorporating 4WD with them, to get to where we are today.'

The result, the Supercar Lite, referred to as the 'Control 4', is a collaboration by Avitas and OMSE. 'Avitas builds the chassis and OMSE does the rest, installing brakes, engine, transmission, etc. Both Avitas and OMSE are extremely dedicated to make this a huge success globally. The investment we made is high,' says Eriksson, ever confident that it will pay off.

With the first dozen cars built, and since the GRC series races are primarily in the US, OMSE uses its GRC Supercar shop in southern California as the base for Lites racing operations. It is near Los Angeles, in Huntington Beach, home to many neighbouring performance companies.

Responsibility for running the GRC Lites program day-to-day falls to Brad Manka, the lone American on this end of the international venture. But Manka's background in a diverse number of US racing series gives him great familiarity with the tracks, suppliers, travel, and common issues the team will encounter Stateside. He oversees the crew for maintenance, set up, transport, and the repair of the vehicles.

'The idea was to build something that we could run a full season and not have to worry about rebuilding engines and gearboxes after every round,' Manka explains.

One objective was to keep the major components of the same quality and robustness as those found in the OMSE Supercars. According to Manka: 'Everything is overbuilt, down to the brakes, which are the same as we have on the Supercar. The Sadev gearbox is the same too.'

ANDRE LAVADINHO/AGENCE S PRESSE

The Ford Duratec engine provides the base. OMSE, with Mountune, reduce capacity to 2.4 litres, with an 8,200rpm red line and it produces 310bhp

CHASSIS

The vehicle was 100 per cent CAD-designed, and included full FEA stress analysis of the roll cage. Making the chassis all tubular steel, and not based on a production unibody, saved production time and cost, as well as making component accessibility and repair that much simpler. The CDS roll cage was submitted for FIA approval; the GRC is sanctioned by the SCCA, who generally follow FIA regulations.

Chassis 'clips' are designed for easy replacement of the front and rear structures. The welded tube structures are bolted with plates onto the upper area of the cowl structure in front, and to the firewall in the rear, four bolts per side. At the bottom, they are attached with welded-in square tubing, which is cut when replacing the clip, preserving the roll cage/centre section of the car. Separately, a cage above the engine bolts off to remove the engine, and another bolted-on structure protects the transmission.

DRIVER SAFETY

From a driver safety point of view, in addition to the roll cage, the cars are well-equipped. They come with an FIA-approved Sparco seat, six-point belts, and driver-side window nets. At least one driver has been allowed to change his seat to one as good as, or better than, the original. Driver Austin Dyne prefers to use the Randy LaJoie, NASCAR style seat, SFI 39.1 approved, with elaborate shoulder support and head surrounds. As in all major racing series today, drivers are required to wear a HANS device.

From a driver safety point of view, the cars are very well-equipped

BODY

The bodywork is carbon/Kevlar composite, capturing the basic shape of the Ford Fiesta. Actual Fiesta doors are used (on one side: steel left, composite right) but the rest of the shell is all new. The production Fiesta windshield and cowl area helps define the body, and keeps it production in appearance.

With top speeds generally less than 75mph, aero development was not given high priority. The wing design is roughly the same as that used on the Fiesta Supercar, but it has been slightly narrowed.

Although the cars are currently styled like Ford Fiestas, OMSE insists it is not a Ford program – they are open to other brands' bodies being used, for example in the case where another auto manufacturer has a driver development program. They could then use one of that company's body styles to maintain alignment of the driver with his or her supporting brand. Eriksson promises 'there will be more body models coming in 2014.'

Dimensionally the cars are similar to GRC Supercars, although slightly narrower. The wheelbase is the same as the Fiesta, at 2489 mm. The competition weight minimum for GRC events is 2625 lbs (1190 kg) with driver. Assuming a driver weight of 170 lb (77 kg), ballast of about 25 lb (11 kg) is required.

SUSPENSION

Suspension consists of double A arms front and rear, with rocker operated, coil over shock units, Eibach springs and Öhlins dampers. The steering rack is assisted by DC Electronics' power system, while sway bars with plenty of adjustment complete the arrangement.

In the spirited competition of rallycross events, front suspension is vulnerable to damage, and replacement of bent arms is common. Early on, when OMSE saw that the lower arm attachment tabs were pulling out, pick-up point reinforcements were welded into all the cars to limit damage to only the arms.

Suspension travel of 270 mm is sufficient for jumping 'as long as drivers are not landing

on the nose or tail of the car,' notes Manka. GRC courses tend to typically have taller jumps than those in the ERC.

Thanks to nose landings, another running design change was made. Initially the front body – hood, fenders, facia, and valance – was one piece. OMSE found they needed to separately mold the lower front, to prevent the need to replace the whole front body piece when only the front valance was damaged. A one-inch square steel tube was added behind the valance, with sacrificial attachments and 8mm bolts, so that when cars do land on the nose, energy is absorbed and damage is not telegraphed to the chassis.

POWERTRAIN

Putting out around half of the power of the 600hp GRC Supercars, the engines are a joint development between OMSE and David Mountain's Mountune Racing, located in Essex, England. The block of the 2.5L, four-cylinder Ford Duratec is the starting point, altered by an OMSE/Mountune-designed cylinder head, intake manifold, oil pan, and 'rotating assemblies', while the cam cover reads Mountune, not Ford. AEM Electronics supplies the Infinity Electronic Control Unit.

Reduced in displacement to 2.4L and converted to dry sump, the units crank out a consistent 310hp, and have their redline set at 8,200rpm. The engine is longitudinally mounted ahead of the rear axle line. All engines for the Lites, like those for OMSE's Supercars, come from the UK. But Mountune is also looking at opening a facility in California, which might change that.

To transmit the power, a Sadev transaxle uses the same robust gears and cogs as the Supercars. The system provides permanent four wheel drive acting through front and rear limited slip differentials. At the front, the drive shafts run through the suspension pushrod assembly. The six-speed sequential shifting action is controlled by a centrally mounted lever, not paddles.

Slowing the car is the job of the large, four piston Alcon brake system. These feature 330 mm diameter vented steel disks.

Steel doors for the Fiesta-based Supercar Lite are taken from the roadcar

CHASSIS TUNING

Although the cars are meant to be identical, drivers do have some control over set-up. They have a say beforehand in shock and sway bar settings, ride height, tyre pressure, and alignment. They cannot change springs, but can adjust the rocker bellcrank ratio to make the spring rate more linear or progressive. Once inside the car, brake bias is all the drivers can adjust. 'That keeps it as much about the driver as we can, and not somebody with a bigger checkbook trying to buy the parts to go faster,' Manka says.

Electronic data acquisition is accomplished via the AIM Dash. Connected to the ECU, it monitors the lambdas, temps, and pressures. AEM has built a software 'log book' to provide OMSE with a history of revs, temperatures, etc, for all engines, in case questions come up regarding equality of engine performance between cars.

OWNERSHIP

Drivers can lease or buy the cars, all of which are maintained, repaired, and transported by OMSE, providing 'arrive and drive' convenience. Another option, coming into play next year, is for a driver/team to purchase the car and do the maintenance themselves.

'You can buy your own car and take it home tomorrow,' exclaims Manka. 'Run your own team: $185,000.'

On the subject of teams "tinkering" with the cars, Manka was confident that not much could go undetected. 'It's the tech inspector's job to determine that they haven't been tampered with. The engine and gearbox are sealed. [The teams] can't get into the ECU. We have fixtures to check suspension pick up points.'

In the end, with the Lites, it becomes the driver's skills that are more important than the final, fine tweaking of the car, emphasising the series' role as a driver development school.

'Rallycross is the future, and more young people will be doing this'

THE FUTURE

With the 2013 GRC Lite season complete – the last event was 7 November – and with more customers in line, Eriksson sees a bright, global future.

'The car works great; it is homologated and prepared for FIA rules,' he says. 'In 2014, we are starting a new series in Scandinavia with STCC that looks to be good. This is the second series, with more to come. I have several countries interested, plus schools, and other interesting programs. Rallycross is the future, and more young people will be doing this professionally in the future. We will have the future driver stars coming from Lites.'

TECH SPEC

OMSE Supercar Lite

Engine
Type: Ford Duratec block, with Mountune/Olsbergs: head, intake manifold, pan, valvetrain
Cubic capacity: 2400 cc
Number of valves: 16
Position: longitudinal, rear
Number of cylinders: 4
Maximum power: 310 bhp
Torque: 220 ft. lbs.
Maximum revs: 8,200rpm
Top Speed: 75mph, as currently geared

Transmission
Type: Transaxle, permanent 4WD
Gearbox: Sadev BV5 4×4 central transaxle, six-speed sequential
Clutch: Alcon, 2 plate

Chassis
Frame: welded steel tube frame
Bodywork: carbon/Kevlar composite

Suspension/brakes/steering
Suspension: double wishbones and pushrod-rocker arm spring/damper actuation at all corners
Springs: Eibach coil
Dampers: Őhlins TTX44 twin tube progressive
Wheel travel: 270mm
Anti-roll bars: front and rear
Steering: rack and pinion, with DC Electronics power steering assist
Brakes: hydraulic double circuit brake system with Alcon one piece, 4 piston, light alloy calipers
Brake discs: ventilated steel
Diameter (front): 330 mm
Diameter (rear): 330 mm
Wheels: Motegi forged aluminum, 8"X17"
Tyres: Cooper molded rallycross

Dimensions
Length: 3800 mm
Width: 1800 mm
Wheelbase: 2489 mm
Weight: 2,625 lbs. including driver
Fuel tank: 20 litres


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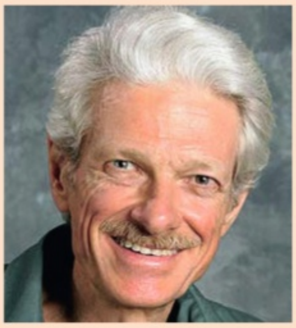

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Inertia damping and reducing tyre hop

Tyre shake in drag racing can be reduced, but eliminating it entirely is a challenge, whatever buzzwords you apply to the task

QUESTION

Just finished your October column in *Racecar Engineering* and your comment about using inertia damping to damp tyres got me to thinking, specifically regarding drag racing. Tyre 'hop' is one of the major contributors to loss of traction in the upper drag racing classes – Pro Stock, Fuel Funny Car and Top Fuel. Watching slow motion video of this phenomenon you can see the tyre begin to deform and then become unstable as it starts to go into tyre hop. Would it be possible to reduce or possibly even eliminate this by using a properly designed and applied inertia damping device?

They do have minimum weights: I think that Top Fuel is 2350 lbs (1066 kg) and Funny Car is around the same. I would estimate that each of them probably has at least 70 per cent of that weight on the rear wheels.

I can tell you that if an inertia type damper worked, the NHRA may possibly require these cars to have them as it could have a great effect on the 'show'. They don't like races that involve tyre smoke. Also, there might be a positive related to the engine life, as once the tyres start to spin the engine load goes down, cylinders go out from no load and then major engine damage can (and does) occur. I also think that most of the cars could easily find a place for some extra weight if the inerter actually worked, as many have ballast.

THE CONSULTANT SAYS

I do think this might have possibilities.

First, I should point out that I do not consider myself a real expert on oscillatory phenomena. I do know a bit, however, and *Racecar Engineering* readers are welcome to comment and enlighten me further.

I don't think inertia damping can entirely prevent tyre shake. I think it might reduce the severity, but chances are that a car will still need to avoid the occurrence of significant tyre shake to get a good run. However, inertia damping could possibly win its user a race in a case where both cars get tyre shake.

I don't think inertia damping can entirely prevent tyre shake, although it might reduce the severity

I have not had the chance to study tyre shake videographically, but my understanding is that it is a combination of two kinds of oscillation, provoked by stick/slip effects at the contact patch. The tyre takes a bite, wraps up, breaks loose and unwraps, then repeats the process many times in quick succession. This subjects the car to both vertical and longitudinal oscillatory excitation, and often leads into complete 'up in smoke' breakaway.

The cars in question generally have locked axles, so the tyres tend to stick and slip in-phase, but I can imagine them – in some cases – oscillating out-of-phase. That would produce oscillatory roll and yaw excitation in addition to ride and thrust oscillation.

We can't necessarily prevent the basic stick/slip action at the contact patch with a damper, but we can to some extent damp the resulting oscillation of the vehicle.

Some of the vehicles in question have rear suspension, and some are rigid. They are all subject to tyre shake. Where there is rear suspension, we have the possibility of mounting an inertia damper on the axle as well as on the frame.

BUZZWORD STATUS

Digging a bit into the question of how inertia dampers work, and what it takes to optimize them, one quickly discovers that the term 'inertia damper' seems to have attained buzzword of the hour status: it is presently being used to describe almost any kind of damping device that incorporates any form of inertia-sensitive element.

In mountain biking, dampers and forks with acceleration-sensitive valves are being sold as inertia dampers. We have the Cambridge/McLaren/Penske 'inerter' or 'J-damper', which spins a little flywheel when the suspension moves. (To what purpose I cannot imagine, since we otherwise go to great lengths to minimize unsprung component inertia.) Evidently there is even some fictional device in *Star Trek* called an inertia damper. I suspect this has much to do with the buzzword effect.

In the current context, what I mean by an inertia damper is a device that uses a mass that moves in opposition, or at least accelerates in opposition, to the mass to be damped. This

Tyre hop in drag racing generates a loss of traction

achieves damping by destructive reinforcement of oscillations, or by friction, or by some combination of these.

Probably the most familiar form of such dampers in cars would be found in crankshaft torsional dampers, often erroneously called harmonic balancers. There are two basic forms of these, and they offer some insight into the possibilities and limitations of such devices.

The most common form of torsional damper, sometimes called an elastomeric damper, has an inertia ring around a hub, with a layer of rubber in between. The rubber serves as a torsional spring. The ring then has a rotational natural frequency. This is chosen to cancel the natural frequency of the crank. The idea is to get the ring trying to accelerate one way while the crank snout is trying to accelerate the other way. The forces then oppose each other and the acceleration of the snout is diminished. As the rubber has some internal hysteresis there is some frictional damping as well.

One drawback to this approach is that for best results the damper must be tuned to the rest of the combination. In a stock engine, the combination is known so this can be accomplished, although there may remain undamped modes of vibration.

In modified engines, the torsional natural frequencies can be different than stock. When we lighten the rods, pistons, and counterweights, we raise the natural frequency. Sometimes rods used for racing are heavier than stock, for more strength. That, and the corresponding counterweighting, lowers the natural frequency. When we drill the rod journals, we raise the natural frequency. When we increase the stroke or use smaller rod bearings, we lower the natural frequency. By using undercut counterweights to reduce the overall mass of the crank we lower the natural frequency. If we use small-radius counterweights with tungsten to reduce rotational inertia, we raise the natural frequency. These variabilities make it hard to optimize a general-purpose elastomeric damper, or any kind of damper that uses springing and cancellation by choice of frequency, for aftermarket applications.

The other kind of torsional damper is the frictional type. These can use Coulomb friction (sliding friction) or viscous friction. In either case, there is an inertia ring completely enclosed in the body of the damper, and free to rotate within it, constrained either by spring-loaded friction surfaces or by silicone damping fluid in the clearance between the inertia ring and its housing.

Frictional dampers generally will damp any oscillation, regardless of frequency. There is no worry about constructive reinforcement (resonance) at non-optimal excitation frequencies. The damping mass has no natural frequency: there is no springing. The unit is non-oscillatory.

Applying the same principles to a linear damper on a car frame, we could use a mass working against a spring, with or without a hydraulic or coulomb friction damper. If we use just a sprung mass, the system will be highly frequency-sensitive. If the mass is to move vertically with respect to the frame, to damp z-axis oscillation, it will have to be supported on some form of springing, and will therefore have some natural frequency, unless it's overdamped (damping ratio >1, or damping coefficient greater than critical, making the system non-oscillatory).

However, the springing can be made very soft, and hydraulic damping can be provided that will make the system overdamped. The damper will then suppress all likely excitation frequencies.

One possible physical arrangement might be a mass on an arm, held up by a coilover, with a very soft spring that would require a spring compressor to install. One of these on each side of the car would damp both roll and ride oscillation.

For longitudinal or x-axis damping, we could have a mass on an arm that hangs straight down at static condition, and swings backward and forward in response to longitudinal accelerations. This could be used with just a hydraulic damper, and no springing.

As with the z-axis damper, we might use one of these on each side of the car, and get damping of yaw oscillation.

MORE EFFECTIVE

Such dampers would become more effective as we increase the mass of the inertia weights.

Finally, we might take advantage of the fact that tyre shake involves a rotational oscillation as well as a vertical and longitudinal one. We might put a torsional damper at the hub of the wheel.

We might also borrow from dirt Late Model technology: react axle torque with a torque arm, and use a coilover for the drop link. There are other ways to damp axle housing rotation as well, such as horizontal shocks.

Again, I would not hope that any of these ideas would eliminate tyre shake. However, they might control it to some degree, and might in some cases be enough to win a race if your competitor also gets tyre shake.

We might take advantage of the fact that tyre shake involves a rotational oscillation as well as a vertical and longitudinal one


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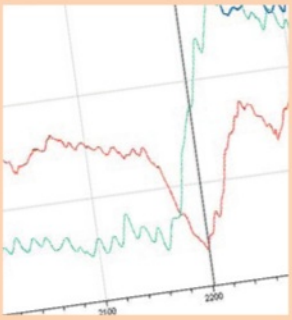

Databytes gives you essential insights to help you to improve your data analysis skills each month, as Cosworth's electronics engineers share tips and tweaks learned from years of experience with data systems

To allow you to view the images at a larger size they can now be found at www.racecar-engineering.com/databytes

The formula of restriction

Databytes looks at the forthcoming F1 fuel flow restrictions and the technology used to police them

In recent years, motorsport has seen a move towards the use of energy recovery systems, with the view to making the sport more environmentally friendly while promoting the development of greener technologies.

Now, in order to promote fuel efficiency, the 2014 Formula 1 rule changes will see fuel mass flow restricted to 100 kg/h above 10,500rpm. Below, a formula for the maximum fuel flow will be applied. In this month's Databytes we consider how these restrictions will be enforced and look at why the governing bodies are looking towards new technologies to police them.

Rather than using a mechanical restrictor, similar to the way that boost pressure is restricted in turbo-charged engines, the FIA have chosen to monitor flow rate through an onboard data logger and impose a penalty should a team exceed the permitted limits. This requires a reliable method of measuring the flow rate while not affecting the flow itself, and an ultrasonic sensor capable of sampling fuel flow up to 4000 times a second is to be selected for the task.

In this modern era, where internal combustion engines are controlled using powerful electronics capable of running engines at over 20,000rpm, you might wonder why the engine electronics themselves can't report the fuel flow – after all, the cars run on an FIA-specified ECU with FIA-homologated software.

The control of an engine is complex, but when you look at the fundamentals it's possible to calculate mass flow rate considering injector opening times, fuel density, and the fuel pressure at which it is stored. In fact, many ECU suppliers provide the ability to calibrate fuel based on fuel mass as well as injector opening time. The following figure shows the instantaneous fuel mass that is being calculated from the ECU fuel map at a given speed and engine load.

It can be seen from the data that the fuel mass being injected, *injMassTotal*, is also affected by other ECU strategies. For example, when the engine speed drops fuel is cut as part of the overrun fuel cut strategy. Later in the outing, small spikes in *injMassTotal* can be seen. From further analysis of the data, it can be determined that the spikes are due to the gear shift strategy, which requests a downshift throttle blip to generate a torque reversal in the gearbox so that a new gear can be selected more easily.

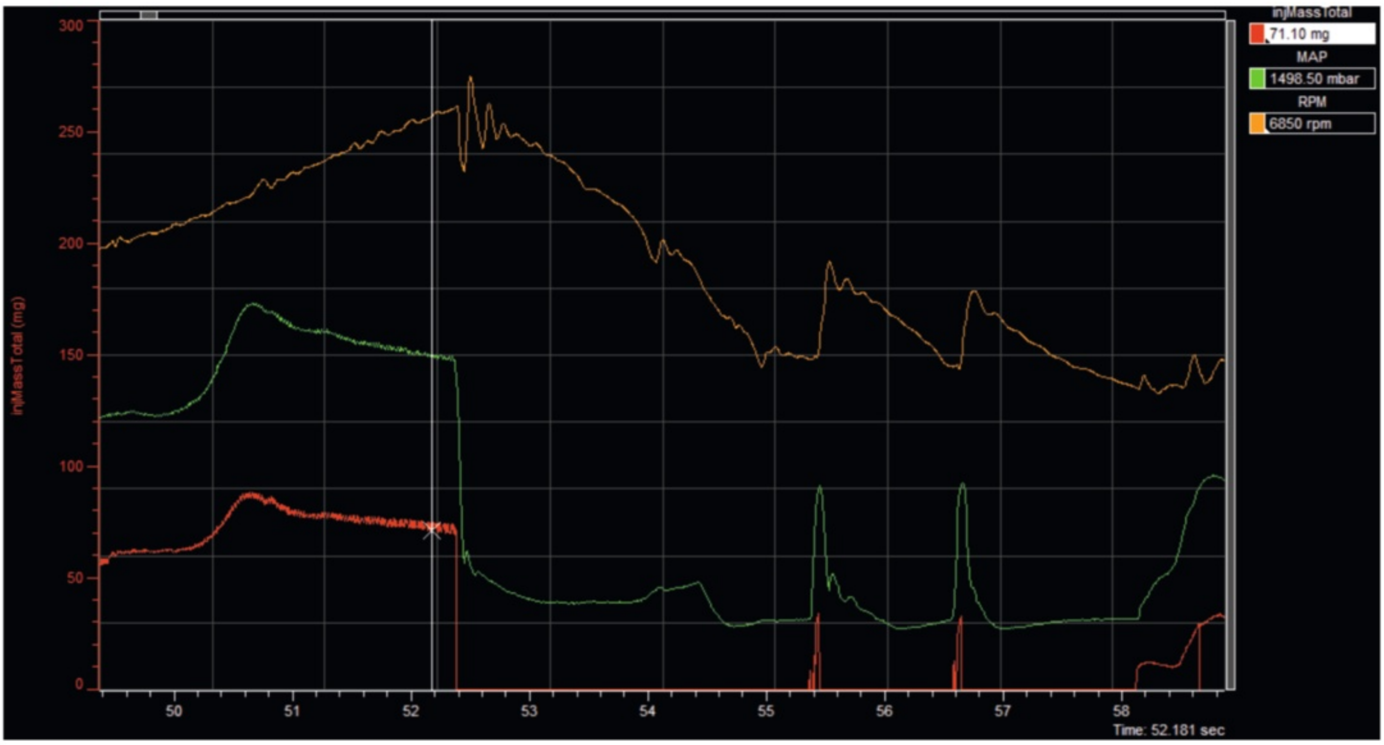

Figure 1: Varying fuel mass dependent on engine speed and load

The accuracy of these calculations is dependent on how well the compensation parameters are calibrated

For an engine to accurately deliver the required amount of fuel at each injection point there are a number of factors that must be considered when calculating how long to turn the injector on. First, the instantaneous fuel pressure must be closely controlled and monitored. In modern engines, fuel can be injected directly into the cylinder head; to achieve this it's necessary to sufficiently pressurise the fuel to overcome the pressures seen in the cylinder head when fuel is being injected.

It is necessary to inject fuel at different points in the combustion cycle to maximise engine performance, so the pressure differential across the injector tip must be modelled, and cylinder pressure injector flow compensation applied when calculating how long the injectors should be open. The accuracy of the model will play a vital part in determining the accuracy of any fuel calculation performed.

Additional compensation is also required for changes in fuel temperature and the effects of variation in battery voltage. Battery voltage compensation is relatively straightforward, as injector manufacturers will specify flow rates at different voltages – of course, for direct injection applications this is not required, as the injectors operate at voltages up to 200V to enable the precise control required by direct injection engines. In the case of fuel temperature compensation, it is necessary to consider the heating effects that occur when the fuel reaches the injector tip. When the injector tip heats up, as the engine speed and load increase the fuel will expand. At higher engine loads, the injector needs to open for longer so that the correct fuel mass is injected into the cylinder.

Figure 2 shows fuel calculations made as part of a standard direct injection application, as this information is required to ensure the correct amount of fuel is sent to the fuel rail on a cyclic basis so that the required fuel pressure is maintained. What should be noted is that the accuracy of these calculations is dependent on how well the compensation parameters are calibrated.

If, for example, an engine manufacturer changed the position of the injectors then the calibration would need to change to account for different heating effects at the injector tip. This information would probably be determined by simulation, and the accuracy of the compensation provided would be dependent on the resolution of the parameters used to calibrate it. Therefore, combining all of these factors with dependency on multiple sensors would make relying on fuel mass calculations to enforce a regulation fraught with problems.

If the teams can't overcome these problems then their engines will be lacking in performance and reliability: being able to accurately determine how much fuel is being injected into the cylinders plays an important role in engine tuning.

The problem here is the effort required to manage this approach, as the FIA would need to check the engine calibration as well as the software used by each car. As a result, it appears that using an independent and homologated fuel flow sensor is the only way that this regulation can be enforced, so let's hope that the technologies being adopted are accurate and robust enough to stand up to the harsh environment of motor racing.

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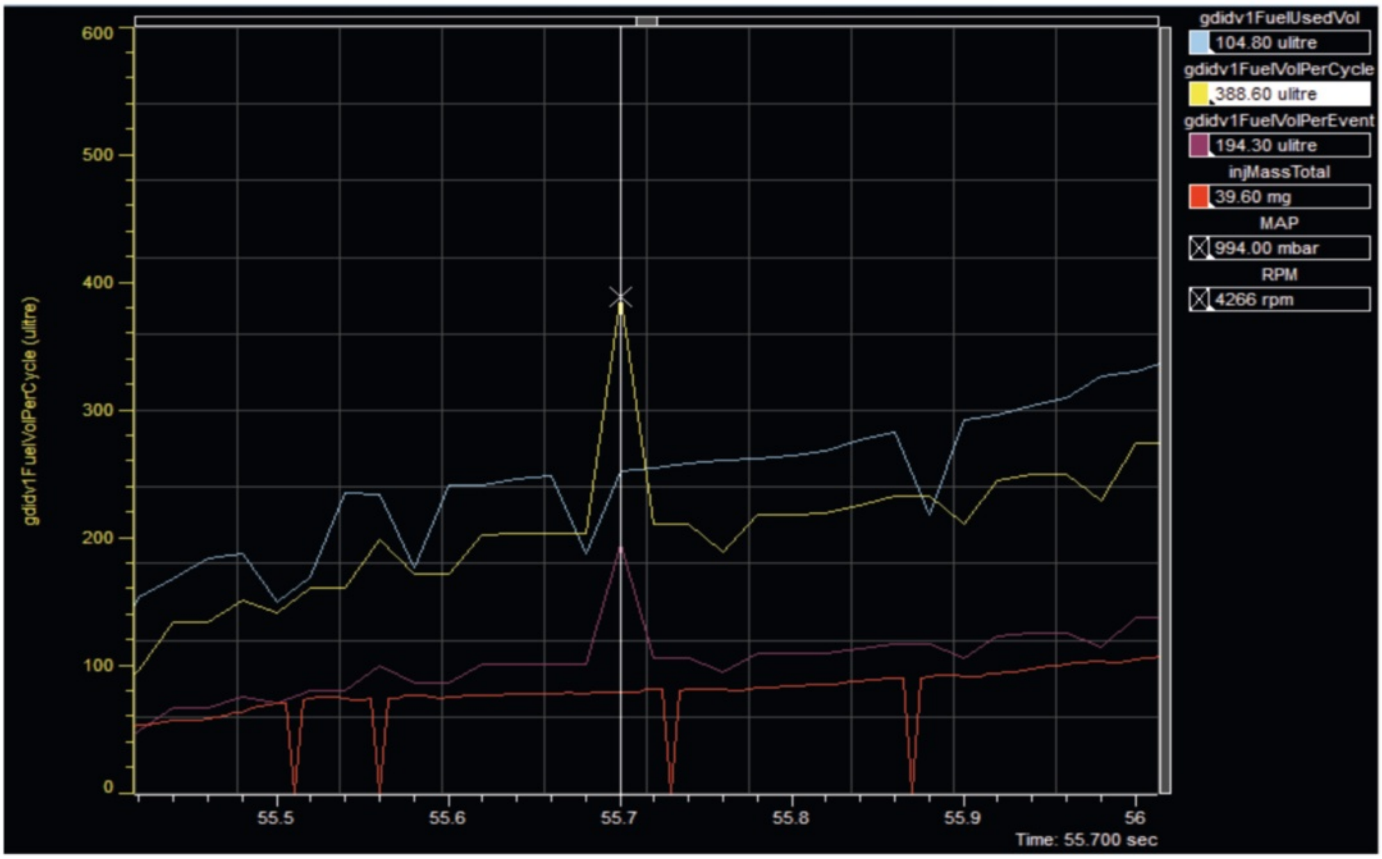

Figure 2: Per Event and Cyclic Fuel Calculations performed by the ECU

Simon McBeath offers aerodynamic advisory services under his own brand of SM Aerotechniques – www.sm-aerotechniques.co.uk. In these pages he uses data from MIRA to discuss common aerodynamic issues faced by racecar engineers

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Students unleashed

University of Hertfordshire Formula Student team wins a wind tunnel session, courtesy of the IMechE and *Racecar Engineering*

Recent trends have seen the blossoming of wings and other downforce-inducing paraphernalia in Formula Student worldwide. How significant are these developments? To answer that question, *Racecar Engineering* provided a half-day session in the MIRA full-scale wind tunnel to the team that the Institution of Mechanical Engineers and *Racecar Engineering* judged to have the best publicity and on-event presence in the 2013 Formula Student UK competition.The winner was the University of Hertfordshire.

It was the first year that the University of Hertfordshire, which has been involved in the competition since 1998, had entered a car with a full aerodynamics package, although aerodynamic designs had been worked on in previous years. Analysing the overall performance of its 2012 contender, UH15, the team, comprising 11 MEng students and 35 other members, decided that the only way to make up the three-second lap time deficit in the sprint competition was with aerodynamics. An aerodynamics group was formed under managers Sam Blood and Karl Mackle, who report to technical director Antonio Carrozza, and manufacturing manager and head of chassis development, Matt Grant.

The first aerodynamic package devised for the 2013 competitions comprised front and rear high downforce wings, with Blood tackling the rear wing design and development, and Mackle the front wing. It was decided to use pre-existing aerofoil profiles with coordinates in the public domain, rather than spend time on bespoke profile design. A shortlist of candidates was whittled down with the help of Star CCM+ CFD software to the Selig1223 'high lift' profile for the main elements and flaps, front and rear. The decision to run with dual-element wings front and rear for this first iteration was taken on the practical basis that this configuration required just one slot gap over the wide adjustment range to optimise the sprint, endurance and acceleration phases of the competition, even though a triple-element (or more) configuration offered greater downforce potential. CFD was used to establish the optimal relative positions and angles of the main elements and flaps, and also endplate size and shape. Cost and time considerations were also involved in the choice of configuration and overall package design, as were overall car design changes simultaneously underway.

The planned quarter-scale wind tunnel test of UH16 with wing package in the University of Hertfordshire's own wind tunnel unfortunately didn't happen because of time constraints, apart from some runs on the wing sections only, which compared reasonably favourably with the CFD data. The MIRA test was the team's first opportunity to derive some hard data on the first integrated aero package.

The team decided that the only way to make up the three-second deficit was with aerodynamics

Preparations for the session

MIRA DATA

As ever we should restate that MIRA's full-scale wind tunnel has a fixed floor and the test car's wheels are stationary. The fixed floor tends to underestimate the downforce generated by ground-effect devices, including front wings. However, with the 'boundary layer control fence' installed and with no downforce-inducing underbody on the car, overall underestimates would be relatively minor, and rear downforce and drag would have been accurately determined.

So, how did the car perform? **Table 1** shows the data in the baseline configuration (maximum wing angles all round) at just 40mph and 60mph. As usual, and of special interest in this application because of the very relevant speed range of the Formula Student competition's dynamic phases, the car was run at two speeds to see if there were differences in the coefficients. The data is shown in **Table 2**, together with the differences

The first iteration full aero package comprised front and rear dual-element wing set

Setting up the split front wing flaps to maximum

The front wing's upwash could be seen to encounter the rear wing's flow field

Flows around the front wing end plate came in for close examination

between the two speeds.

The first observations to make are that although the drag coefficient was rather high, the overall negative lift coefficient was even higher, producing an efficiency figure, -L/D, of over 1.5. Out of interest, comparing this with other open-wheel single-seaters tested for this column, the Formula Student data is part way between the aerodynamic performance of an early 1980s 'flat bottomed' Formula 1 car and the more modern ones we have tested, a 1999 Benetton and a 2007 Honda.

Of significance, though, are the differences between the coefficients at 40mph and 60mph. Aerodynamic forces normally increase with the square of speed so, all other things being equal, the calculated coefficients derived from the logged force data would be the same at the two different speeds. For the coefficients to vary with speed, all other things were not equal. This is not an unusual situation, with the flows over (or more often, under) downforce-inducing surfaces not being fully developed at speeds as low as 40mph. In this instance, what we see in the results is that the front lift coefficient increased by 7.7 per cent from 40mph to 60mph, leading to the conclusion that the flow was better developed (for which read 'better attached') at the higher speed. Remember, all the flaps were at their maximum angles in this baseline configuration, and this may have been too steep for the flow to be adequately attached to the front flaps at 40mph. Wool tufts on the flap undersides confirmed that these flows were not fully attached, and that the higher speed showed improved attachment.

It will also be noted that the rear lift coefficient decreased slightly at the higher speed. This could have been the result of any improvements in flow attachment at the rear being small enough to be masked by the increased mechanical leverage ahead of the front wheels arising from the improved front wing performance. This slightly offloads the rear wheels. Or it could have been the consequence of the upwash of the wake arising from improved front wing flap attachment encountering the rear wing more than previously, thereby slightly reducing its aerodynamic performance. The actual mechanisms are best left to CFD; the wind tunnel simply reports the results measured at the wheels. But the fact that the drag coefficient also decreased, something that is known to occur when a rear wing angle is reduced,

Table 1 - baseline data at 40mph and 60mph, with the differences in 'counts' where 1 count = a coefficient change of 0.001

	CD	-CL	-CLfront	-CLrear	%front	-L/D
40mph	1.158	1.758	0.980	0.778	55.7	1.518
60mph	1.146	1.797	1.055	0.742	58.7	1.568
Difference	-12	+39	+75	-36	+3.0	+50

Table 2 - overall drag and lift forces in baseline configuration, with downforce as a percentage of static weight

	Drag, N	-Lift, N	% of weight
40mph	244.7	370.2	12.9%
60mph	515.6	805.2	28.0%

Tip vortices created the usual fascination at front…

… and at the rear

Cooling flows were also examined

Wing flow attachment was visualised with smoke and wool tufts

for example, suggests there may have been an actual aerodynamic interaction here as well as a mechanical one.

The net result of the front gains and rear losses was a three per cent shift in balance to the front from 40mph to 60mph, something that might be felt by the driver if the track contained corners or braking areas taken at the two different speeds. Of more significance is that for a car with a 50/50 static weight balance, the aerodynamic balance was forward biased even at 40mph, this aspect worsening at 60mph, which would make the rear more skittish as speeds increased, provoking some instability under braking, or oversteer in faster corners if the chassis was mechanically balanced at lower speeds.

IT'S ALL RELATIVE…

The extent of the influence of aerodynamics on handling

Table 3 - aerodynamic forces measured in MIRA at 60mph on the 2012 Dallara F3, and the 2007 Honda F1 with bargeboards removed

	Drag, N	-Lift, N	% of weight
F3, 2012	343.0	841.1	Approx. 14%
F1, 2007*	530.5	803.3	Approx. 13%

**Bargeboards removed*

and grip does depend on the magnitude of the aerodynamic forces relative to the car's weight. So, let's look at the actual forces in that context. **Table 2** shows the overall drag and lift forces compared to static weight.

Thus, at 40mph, the downforce was 12.9 per cent of the car's weight, and at 60mph had risen to 28.0 per cent of the car's weight. At these speeds these are fairly significant increases in the vertical forces acting through the tyres. (To go off on a tangent for a second – an irresistible calculation at this point is to work out the speed at which the car generates downforce equal to its own weight, at which speed it could drive across the ceiling, and it comes to 113.4mph!)

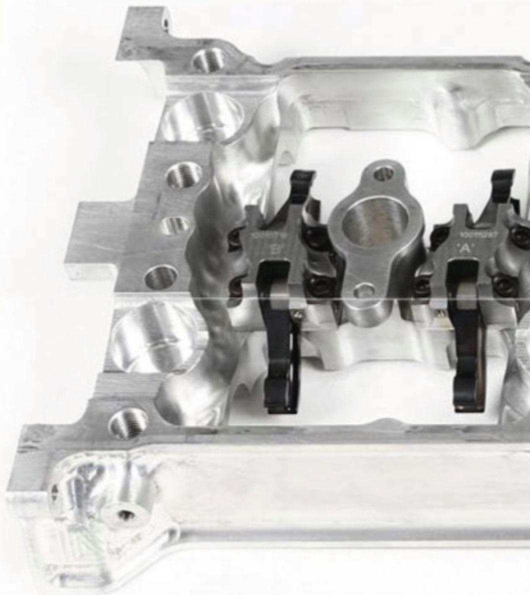
It is never a good idea to compare the data from cars in different categories except out of passing interest, but this also often proves irresistible…**Table 3** speaks for itself.

The levels of absolute downforce generated at 60mph were therefore quite similar to the Formula Student's downforce, but it is the amount relative to car weight that is important, and in that respect the FStudent was well ahead! Clearly the F3 car was much more efficient though, with a lot less drag being created. Two notes of caution: first, the Honda F1's downforce was much greater with its bargeboards; second, both the F3 and F1 car generated a large proportion of their downforce with their floors, and MIRA's fixed floor would lead to a downforce under-estimation of this. Nevertheless the comparisons are interesting and show that the Formula Student car was able to generate a much larger proportion of its weight in downforce at these speeds than either the F3 or the F1 car in the guise mentioned.

Next month we will look at the responses to adjustments made in the wind tunnel by the students.

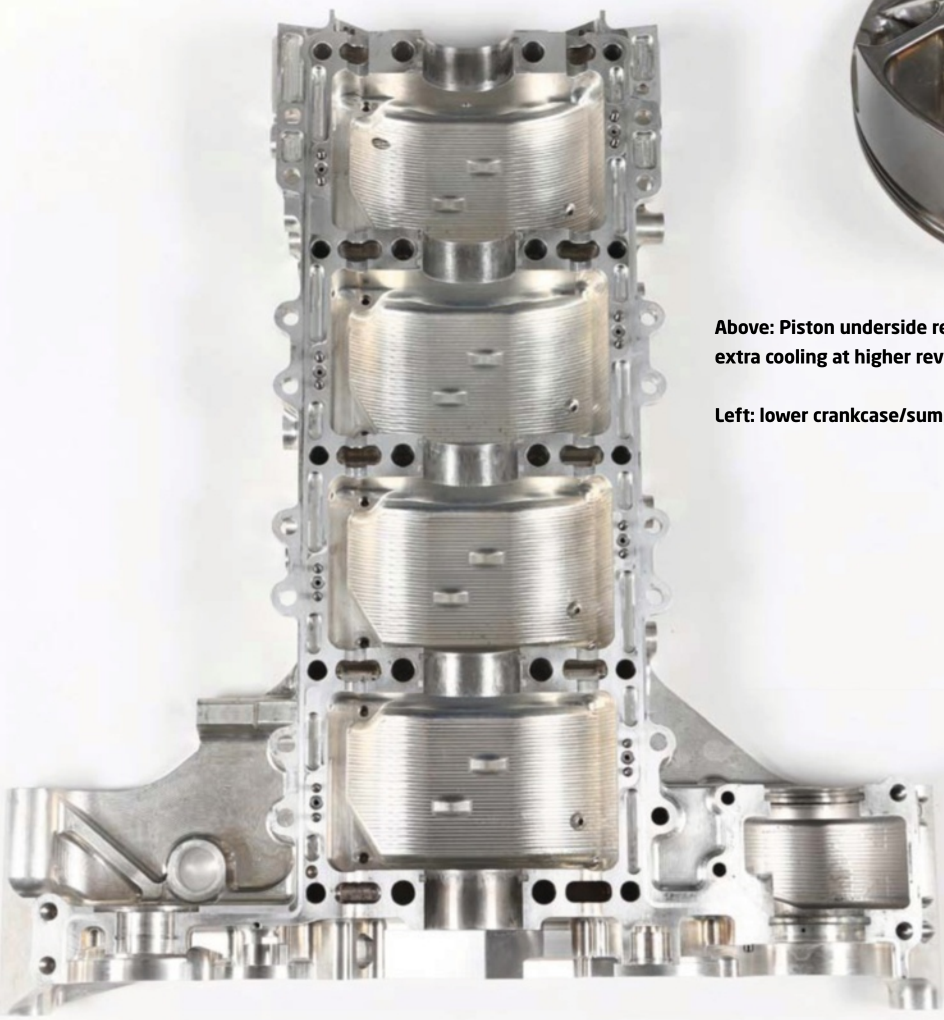
Racecar Engineering *extends its thanks to the staff and students at the University of Hertfordshire Formula Student Racing Team*

Buckets, trumpets and skirts



Cosworth's 2006 CA F1 Engine was its fastest revving engine yet. Marussia races its derivative today

BY IAN BAMSEY



Above: Piston underside required extra cooling at higher revs

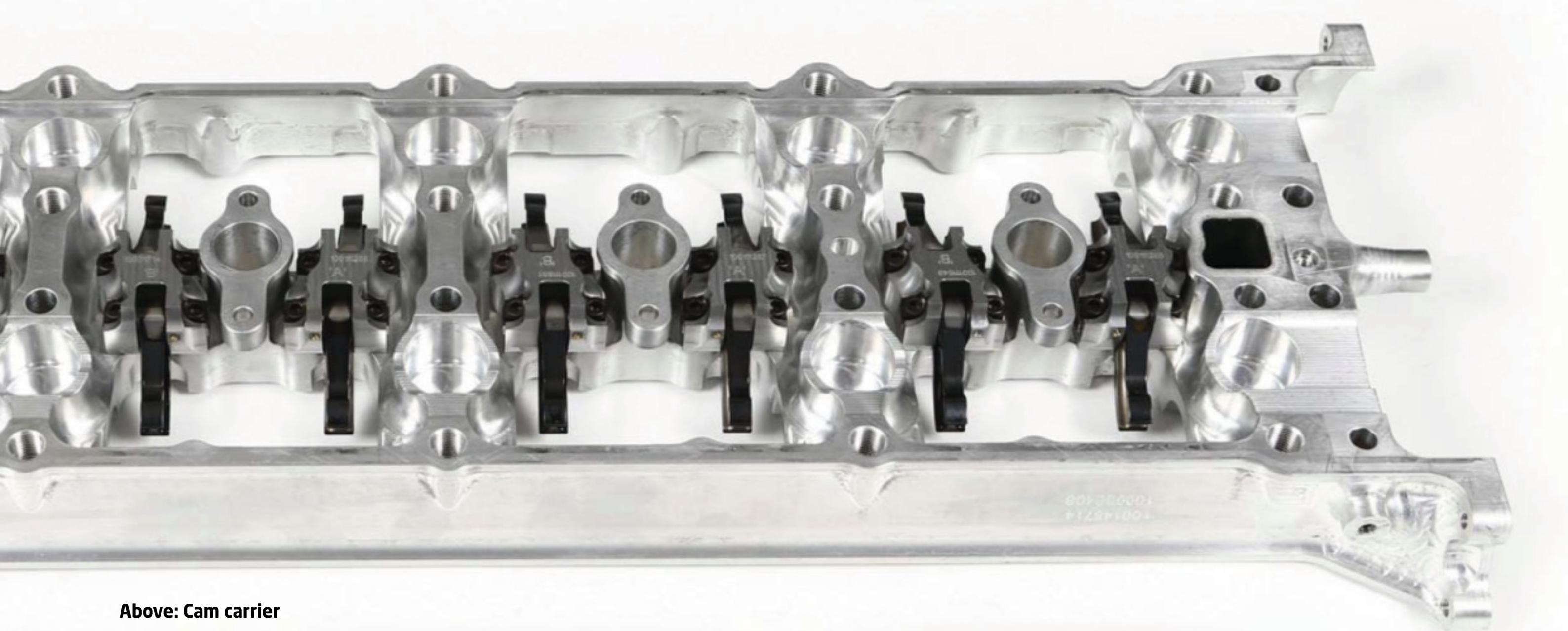
Left: lower crankcase/sump

From 1906 through to 2006, grand prix engine speeds rose ever higher, from less than 2000 rpm to ultimately a mind-boggling 20,000 rpm. Then the rule-maker abruptly halted the march of progress with a 19,000 rpm rev limit for 2007, subsequently reduced to the current stifling 18,000 rpm, plus – adding insult to injury – a moratorium on development. While engine evolution is back in 2014, the emphasis henceforth will be on fuel efficiency rather than outright, untrammelled performance. The glorious Century of Speed is over.

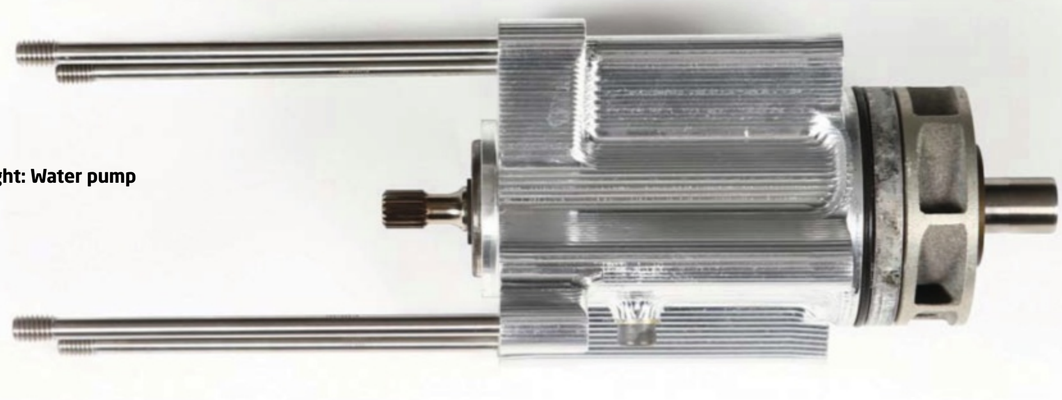
The first Formula 1 engine to attain 20,000 rpm on track was the Cosworth CA of 2006, and it is generally agreed that no rival surpassed it

SPEED FREAK

The first Formula 1 engine to attain 20,000 rpm on track was the Cosworth CA of 2006, and it is generally agreed that no rival surpassed it as the benchmark before rev limiting was imposed. These days the naturally aspirated 2.4 litre V8 CA lives on, powering Marussia in its



Above: Cam carrier



Right: Water pump

close fight against the Renault-engined Caterham for the honour of top dog of the young teams in Formula 1. Of course, operating speed and horsepower steadily climbed during much of the 3.0 litre V10 era preceding the switch to V8s mandated for 2006. It is widely agreed that BMW reached 19,000 rpm first, in 2002. However, engine mileage requirements were lengthened in 2004 and 2005, which had the effect of pegging the ongoing crankshaft speed rise. Representative of the top 2005 V10s was the Toyota that ran to a maximum of 19,200 rpm, and produced an estimated 930 bhp mid-season. All of the 2005 V10s exceeded 900 bhp but it is not thought that any exceeded 950 bhp, with the possible exception of the Honda at the end of the season.

Cosworth's 2005 V10 was the TJ, which had its red line at 19,000 rpm. Indeed, it had taken a relatively long time for the Northampton virtuoso to rise above 18,000 rpm with its V10s. Nevertheless, with the CA it took the uncompromising approach of targeting 20,000 rpm from the outset. This was the first time it had produced such a high-speed V8 – the previous fastest running of the type had been its XF IndyCar engine, which ran to 16,250 in qualifying back in 2002 (immediately before the switch to a Cosworth-supplied spec engine for the CART series).

By regulation, the CA retained the per-cylinder displacement of the existing 3.0 litre TJ V10, which had a 95mm bore. As Cosworth's technical director Bruce Wood remarks, 'To go faster you just have to keep making the bore bigger, the stroke shorter and sort out your valves...'

From the points of view of both associated mechanical stresses and of getting the charge into the cylinder, the CA's 3mm increase in bore size was advantageous compared to the longer stroke TJ (it went to 98 mm, the maximum permitted for 2006). The real challenge was to burn the mixture effectively using such a large bore. As the stroke-to-bore ratio increases, it becomes ever harder to obtain an adequate compression ratio, while clearly the flame travel is lengthened, plus the time for combustion shortens as rpm rises to take advantage of the bore increase.

The geometry of the CA's combustion chamber was assisted by introducing a compound valve angle. Its operation was assisted by fuel pressure. In simple terms, as the time for mixture preparation went down (with increasing rpm) Cosworth had found it needed to exploit higher and higher fuel pressure. As Wood explains, 'The ability these days to phase fuel delivery, to have good fuel preparation, has aided combustion, and the ability to combust the fuel well has enabled us to increase the bore size; that in turn has enabled us to run the engine faster.

'Nevertheless, when we first tried bigger bores in the V10 days, we didn't manage to make them work successfully, because we couldn't get the combustion right. The necessary mixture preparation was enabled by running higher fuel pressures.'

BAD VIBRATIONS

As engine speed increases, so too does the associated vibration. When the V8s replaced the V10s, most Formula 1 engine manufacturers reported problems. A 90° V10 is inherently better balanced than a 90° V8 with a flat-plane crankshaft; the V8 is balanced vertically but not horizontally. Wood reports that when the CA first ran, even with all of Cosworth's experience of V8 engines, this one, running more than 3000 rpm faster than any previous example, took it by surprise in some respects.

'When we first started running the CA, the scavenge pumps, which are held onto the sump with horizontal bolts, would fall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The Cosworth CA 2.4 litre V8 was Cosworth's first engine designed with the specific intention of reaching 20,000rpm

Right: The oil pump & manifold that links it to sump

off. Those are 8mm cap screws, the heads of which snapped off because of the unbalanced force – which is why the CA's scavenge pumps are now secured by Multiphase bolts!

'In terms of the torsional vibration inside the engine, we knew what we were up against, which is why the CA has far more damping devices in it than our previous V10 engines. We have a "compliant" geartrain that has been in our Formula 1 engines for years. Then, in addition, the CA has compliant quill drives within each of its two auxiliary drives, a big viscous damper on the back of the crankshaft, viscous dampers on the back of each camshaft and friction quill dampers in the front of each camshaft.'

Wood says that the design of the CA's piston was key to allowing it to attain 20,000 rpm from the outset. Rival manufacturers also discovered that it wasn't the likes of valve control, combustion or mechanical stress which were ultimately the most difficult hurdle to overcome to reach that level of engine speed, it was the integrity of the heavily loaded 98mm bore piston, which by regulation now had to be aluminium alloy.

The move late in the V10 era to engines running two consecutive race meetings had called for a significant increase in the cooling provided to the underside of each piston by means of oil squirt jets. At the same time, many V10s explored piston materials more exotic than aluminium. Aluminium beryllium was long outlawed, but in 2005 MMCs (metal matrix composites) were commonplace.

'We came out of that quite well because we hadn't progressed to MMC pistons. We were doing well with conventional materials still permitted for the CA,' notes Wood. 'I think the fact that MMC hadn't become part of the norm for us played to our advantage under the 2006 rules.

'That was indicative of how good we were getting with our piston analysis – we hadn't had to go to MMCs, whereas some of our rivals had. Thermal coupling into the FEA of the piston was absolutely key to our success in being the first to run a Formula 1 V8 successfully to 20,000 rpm, not just to reach that level on the dyno but to the extent that teams could use that rpm level during a race. The CA ran to 20,000 rpm on track from the first grand prix of the season.'

For Cosworth, the CA ushered in the concept of a compound valve angle. The geometry of the finger followers is designed to accommodate it. The advantages are a superior combustion chamber shape and a slight increase in potential valve area for a given bore size.

Unlike many rivals, Cosworth didn't develop moveable trumpets in the V10 era, which arguably left it in a strong position when fixed trumpets were mandated for 2006. The length of the CA's trumpet depends on engine spec, and through the years it has been varied from around 25mm to 72mm.

ARCHITECTURE

The CA has a surprisingly traditional architecture, with a conventional monobloc (combined block and upper crankcase) that runs from the decks to crankshaft axis height, and a combined lower crankcase and sump that forms the main bearing caps. Its heads even have detachable cam carriers, reminiscent of the DFV's separate tappet blocks. This is in contrast to the TJ, which had an unusual head form, resembling an inverted T.

Wood says: 'We learned that the TJ cylinder head was good for reducing weight but not so good for stiffness. The LK had a deep skirt with cross-bolted main caps. Over the years we tried different things, and we came back to our traditional architecture for the CA. It wasn't the case of that was the way we had always done it – we had tried other things and learned along the way.'

The TJ weighed in at 93kg whereas – despite having two fewer cylinders – the CA came in at the minimum permitted 95kg. Without that 2006 ruling it might have weighed less than 85kg. The TJ might have been even lighter, had it run the same 350-400km as earlier V10s: it had been specifically designed to run 800 km given the rule demanding two events per engine.

The design of the CA's piston was key to allowing it to attain 20,000 rpm from the outset

Mark Webber drove the FW28 powered by Cosworth's CA engine, but it was not the most successful of seasons as Williams finished eighth in the constructors' title, its lowest finishing position since 1978

It follows that the CA's weight doesn't reflect what could theoretically be achieved given contemporary technology. On the other hand, the enforced mass was put to good use in stiffening the structure, in particular at the top end, in the interest of valvetrain dynamics. With hindsight, Wood admits that this was a crucial factor in the quest for 20,000 rpm.

In the overall car context, installation stiffness is always important, so that was another target of the 'excess' weight enforced by the regulations. Wood notes: 'The cam covers are quite chunky aluminium productions, and part of that is engine mount stiffness. If you look at the TJ, that has thin carbon fibre oil-retaining covers that do nothing else. Nevertheless, in effect we had to incorporate ballast onto the CA heads to get the centre of gravity up to what the rules required. The weight consideration did allow us to leave plenty of material to experiment with porting.'

GROOVY BABY

When grooved tyres were introduced to Formula 1 in 1998 it was more advantageous than ever to move weight forward within the car. Cosworth was then supplying the Stewart team, and together they devised the current approach of moving the oil tank from the bellhousing to the front of the engine, so that it nestled into the fuel tank area. Stewart developed a lightweight carbon fibre housing for its gearbox, and the following year Cosworth pioneered the concept of a linerless Formula 1 block with its new CK V10, helping to make it lighter and more compact.

Ever since the first linerless block in 1999, the bores have been coated using the plasma spraying process developed by Sulzer Metco. The block is duly shipped to one of that company's coating plants in Switzerland, where it receives a bond coating followed by a top coat of plasma iron with moly. Back at Cosworth the bores are then hot-honed with dummy cylinder heads in place to ensure that the attachment of the actual heads will not put cylinders out of round. The current coating has proven utterly dependable over the 3200 km endurance test of an engine (after which it will be rebuilt).

Aside from the use of a PVRS, the other key to operating the CA's valves at 20,000 rpm was the deployment of finger cam followers. The first finger follower Cosworth Formula 1 engine was the CK of 1999. The XF followed suit and, as Wood reported in 2003, 'we had lost control of the XD's valvetrain at 15,300rpm – finger cam followers gave us a much smaller moving mass and were essential to running at 16,000rpm-plus.

'We were surprised at the reliability we attained from the finger followers. A bucket is essentially a diaphragm with a skirt – it is inherently less robust. Trying to run buckets really fast, you come out with them dished. You would think the bucket would be stiff, but when the nose of the cam is off the centre, you have this relatively thin disc being bent by it.

'There is also a friction issue with the skirt, which saps some horsepower. But more significant still is the scope provided by finger followers to run more lift and more aggressive cam profiles. We wouldn't design another engine with bucket tappets, unless cost was the overriding consideration.'

DIFFERENT TUNE

In 2006, running to 20,000 rpm, the CA was coaxed to obtain 756 bhp at 19,000 rpm. To prepare for the 2010 season, Cosworth had to retune the CA to the 18,000 rpm maximum imposed by the FIA and convert it to run with the Standard Engine Control Unit (SECU) engine management system. It had to respect the engine development freeze that had been imposed in 2007 (and increasingly tightened). Happily, the CA had been 'quite reliable' in its 2006 Series 6 spec, says Wood. 'There had been no significant reliability issues,' he confirms.

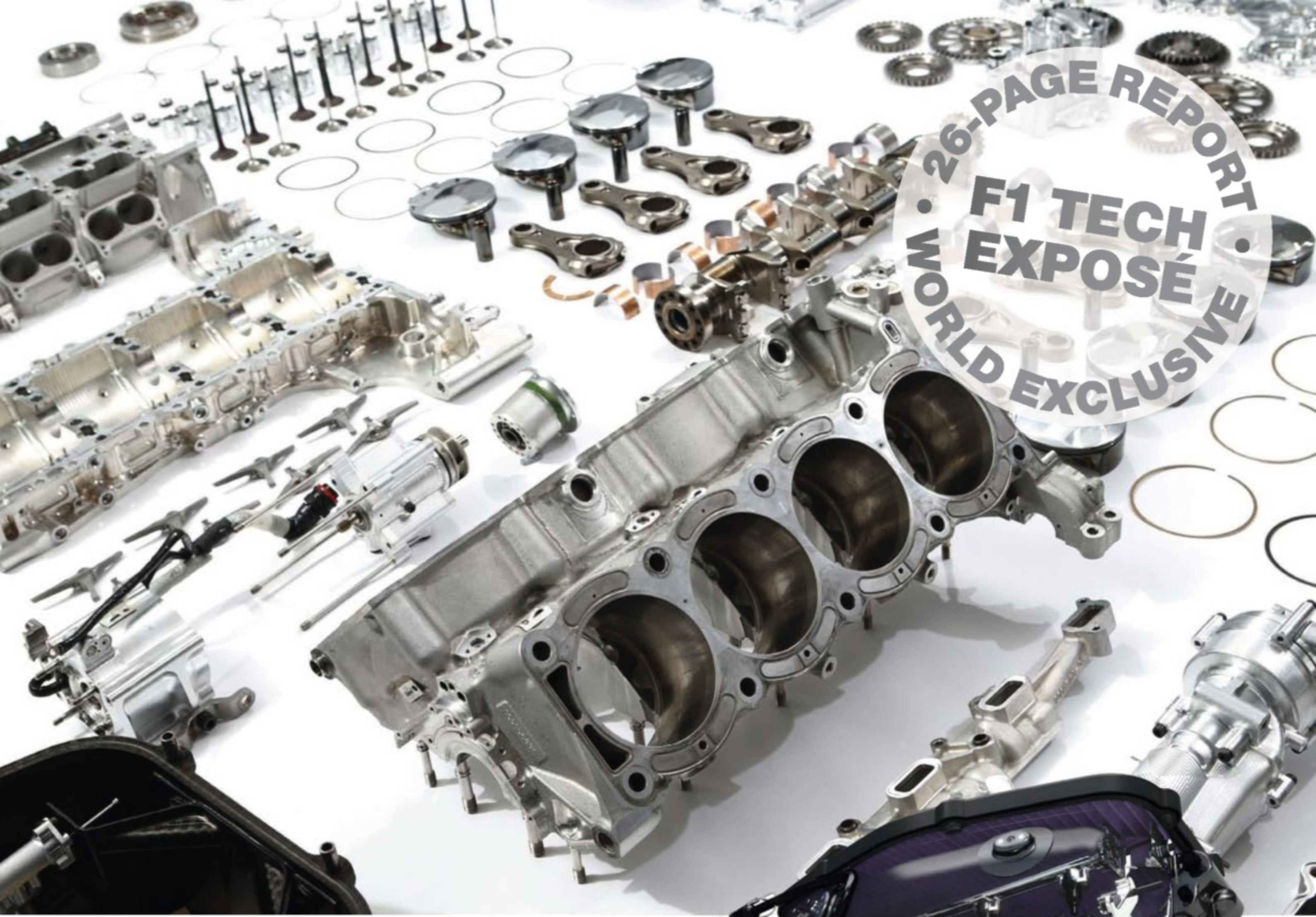
'The modification from the 2006 to the 2010 specification was within the same scope for retuning as given the other manufacturers in the move from 20,000 to 18,000 (via 19,000 for 2007 in their case),' Wood adds. 'But remember that we had to produce engines for five teams at relatively short notice. The main limitation was time, so we quickly had to start making components for the 2010 season.'

In preparation for 2010, Cosworth did GT Power simulation work. 'We were targeting at least 740 bhp for the 18,000 rpm specification,' Wood remarks. 'Where we ended up homologating for 2010 was 772 bhp at 17,500 rpm – better than expected. A lot of that came from improving the airbox. The snorkel and the trumpet tray work together as a system, and on the V8 it is very powerful.

'It is always a struggle with Formula 1 cars, the size of the airbox against the [aero] packaging of the rear of the car. Teams like to run the rear bodywork tight over the rear corners of the airbox, and because of that our 2006 engine had a constraining airbox. We found that if we ran a bigger airbox we could improve the performance, a wider airbox that tunes at a lower speed. With the 2010 engine we told the teams that they would have to design around the airbox that we specified.'

Further progress through to 2013 saw a slight decline in peak power, to 768 bhp, but with the PPS then at 17,250 rpm and an impressive gain of 40 bhp at 13,000 rpm. The power curve was more substantial.

The other key to operating the CA's valves at 20,000 rpm was the deployment of finger cam followers


26-PAGE REPORT
F1 TECH EXPOSÉ
WORLD EXCLUSIVE

Past, present and future

If the properties fit, motorsport will use it, from depleted uranium to unobtanium

It is estimated that the total amount of astatine in the planet can barely be held in a spoon, 30 grams existing on the entire Earth at any one time. It is the rarest element. Being product of radioactive decay, and radioactive itself, it has a half-life of 8.3 hours before decaying to lead. That alone ensures it will not be used in a motor racing application. Practically everything else will.

In the Silicon Valley, around the late '70s there were two popular materials: Expensium-6 and Unobtainium-12, the only ones solving otherwise intractable engineering problems. I have personally been in dire need of these elements on several occasions. Impossibilium, Wonderflonium, Raritanium and Hardtofindium are other elements highly prized in racing.

Base metals are also needed. Lead, useful in ballasting racing cars when new – before they acquire middle-age spread – can be found on church roofs in some

BY RICARDO DIVILA

unsuspecting French, Italian or German villages in the middle of the night when needed before morning tech inspection. Or could. Many of the aforementioned villages are now bereft.

Correlation? It is amusing to think some of that lead had been astatine in a previous half-life.

For use as ballast, the pre-eminent characteristic we are looking for is density, so it occupies the minimum space for a given weight. Balsa wood would not be practical in this case (although I have run a Porsche 917 that had a balsa wood gear-knob), but we could have osmium at 22.587±0.009 g/cm3 or iridium at 22.562±0.009 g/cm3. At $23,000 per kilo, unfortunately that would promote them over Expensium-6.

Tungsten at 19.3 g/cm3 is more accessible, at $110 a kilo. For a while, depleted uranium was used as ballast or engine counterweights. At 19.1-g/cm3 density it was close to Tungsten, and much cheaper. Being declared a serious health hazard and a crime of war to use truncated depleted uranium's racing career, while also explaining its cheapness before.

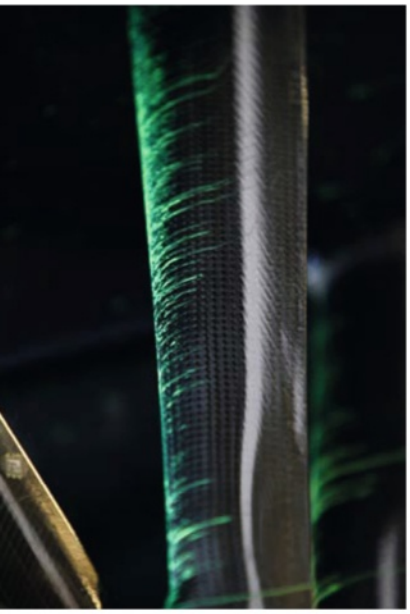
In my Japan days, an unfortunate comment discussing Tungsten's use as ballast for F1 cars led to the disagreeable discovery on my return from a trip to Europe that the team had bought 120kgs of it to ballast the car. Worse, one of the billets had been half machined away to fit on the floor and surround the prop-shaft.

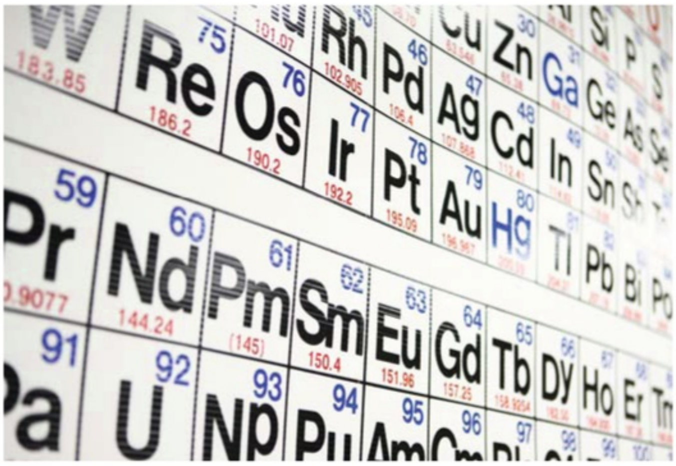
The range of useable materials for racing can encompass everything, given that the mechanical proprieties fit. I have mentioned balsa wood as a gear knob, but the Costin Protos had a full plywood chassis, as did the road-going Marcos, and the Mosquito fighter-bomber demonstrated the use of wood beautifully.

And, of course, the first automobiles had wooden frames derived from the dominant transport vehicles of the time: carriages. The use of bamboo as a frame for bicycles shows it can be close to carbon fibre in structural propriety at a fraction of the cost, Mother Nature having refined the production technique over aeons.

Carbon fibre is a good demonstration that organic can beat mineral (a diamond is carbon, and so are we), but its most remarkable property is its high stiffness to weight ratio @ 21 compared to steel, titanium, aluminium and magnesium, all around seven (in its woven form it is considerably less, but still more than double metallic).

My first experiments with carbon fibre date to around 1978, when a square foot of tissue at £44 cost more than my weekly wage. These days no high-tech implement seems to have street cred without some CF in it, even if it is but a decorative cover. Case in point: an F1 team I was





Impossibilium, Wonderflonium, Raritanium and Hardtofindium not pictured

Hydrogen married to magnesium alloy in the ill-fated LZ 129 Hindenburg zeppelin

involved with, who produced steel wishbones covered with a layer of carbon fibre tissue to make them look all-CF, the design and production of which did not achieve the stated goals of stiffer, lighter and – most importantly – increased reliability. *Meglio apparire que essere*, as the Italians would say.

Nevertheless, we will see more CF in everything simply for its material proprieties, with several major manufacturers investing in volume production in view of high production use. Aerospace is now fully committed: witness the 777.

Gearboxes are already made of CF, wishbones, all monocoques and bodywork likewise, and engine blocks are not far away. It is hard to envisage a racing car without it.

But – as always – the once prohibitive cost of the material has reduced, and it is now ubiquitous. In the 1850s, aluminium was more valuable than gold, being priced at $1200 per kg to gold's $664 per kg.

Incidentally, there is more aluminium in the Earth's crust than any other metal. At about eight percent, aluminium is the third most abundant element in the crust, behind oxygen and silicon. As recycling aluminium uses only five per cent of the energy needed to produce it from bauxite look forward to seeing aluminium being used more than steel in road cars, as greenness becomes de rigueur. It has already replaced that other once-stalwart material, copper, now rarely used in radiators despite its superior thermal properties.

It's come a long way from its origins as alum, used since ancient times for dyeing, tanning and to stop bleeding. Alum is potassium aluminium sulphate. In the 1750s, German chemist Andreas Marggraf used an alkali solution to precipitate a new substance from alum and it never looked back. The Hall-Héroult process dropped its price 97 per cent in just five years.

Corinthians vii. 8-9 (AV) says 'But if they cannot contain, let them marry: for it is better to marry than to burn.' The initial design of the LZ 129 Hindenburg zeppelin featured the worst of both worlds: marrying hydrogen to magnesium alloy is not a good idea…

The lack of helium as an inert non-flammable gas due to embargo may have pushed the use of duralumin.

Elektron was a magnesium alloy developed in Germany during the First World War as a substitute for aluminium alloy. Elektron is unusually light and has a specific gravity of about 1.8 compared with the 2.8 of aluminium alloy.

The duralumin frame of the zeppelin was covered by cotton cloth varnished with iron oxide and cellulose acetate butyrate impregnated with aluminium powder added to reflect both ultraviolet, which damaged the fabric, and infrared light, which caused heating of the gas.

Titanium is extensively used in paper, paint and toothpaste, for which uses 95 per cent of the world's production is destined in the form of titanium dioxide (TiO_2) pigment. The remainder does sterling work in lightweight, high-temperature environments. (Think the Lockheed SR74 Blackbird skin). It has drawbacks, specifically notch-sensitivity in machined parts, and in its first appearance in motor racing was too often used to replace identical parts in steel.

Lighter, yes, but not as stiff, and as a result its use led to numerous failures. In forgings titanium is very good, and if welded in a proper inert atmosphere it is good in fabricated components.

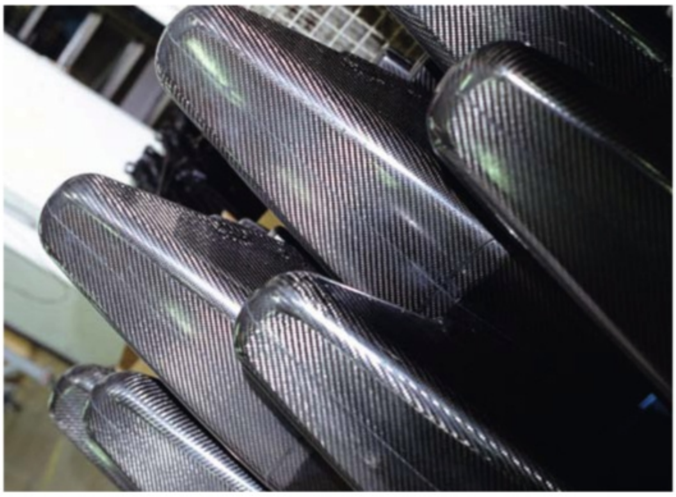
Steel remains the queen of metals, the foundation of engineering. There are countless alloys tailored for different applications, and metallurgy brings new alloys every day, like advanced high strength steel strength/elongation performance of 950 MPa/35 per cent, 1200 MPa/20 per cent and 1600 MPa/15 per cent, and adding high levels of Cobalt to steels to create the toughest/strongest/hardest (not a tautology) steel next to Unobtainium: Aermet 100, 310 and 340.

Steel has been in use for centuries, and is a well-examined material. In the past, Indo-Persian swords consisting of Wootz steel were highly valued throughout India and the Middle East. Wootz steel, both stronger and more flexible than ordinary steel, was made out of crucible-fired sand consisting of iron and tungsten carbide, which occur naturally in very few places, almost all of them in central Asia.

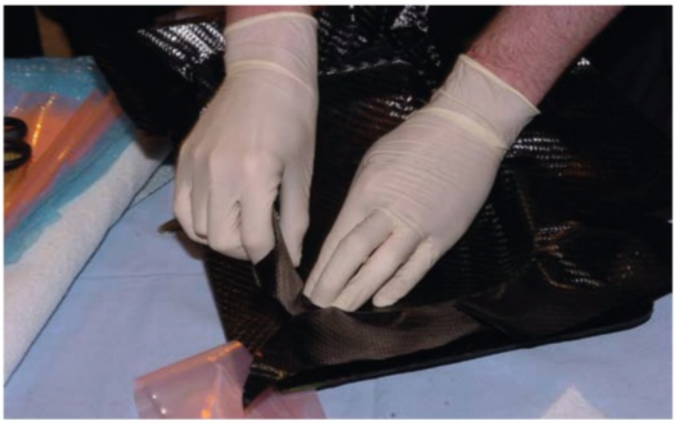
The steel was characterized by a pattern of bands or sheets of micro carbides within a tempered martensite or pearlite matrix, and is thought to have been developed in India around 300 BC. The process for making Wootz steel was lost for several centuries after the ore ran out; it was only recently that chemical analysis demonstrated why it was so. (The ore contained trace amounts of vanadium, which created an unusual spiky crystal structure in the solidifying ingots). The forging process, which saw blades being hammered, re-folded and built up as a millefeuille, produced the fabled Damascus swords.

Metal-matrix composites point to new ways of strengthening alloys. They are a diverse class of

Titanium does sterling work in lightweight, high temperature environments, such as the Lockheed SR74 Blackbird skin



It is hard to imagine a racing car without carbon fibre - it is now being used in road car engines and plans are afoot for a carbon block to debut in 2015



The laying up of carbon fibre is now a considerably more accessible skill. Carbon chassis, suspension parts and aerodynamic parts are readily available

materials that consist of a metallic alloy matrix typically reinforced with a ceramic phase in the form of particles, platelets, whiskers, short fibres, and continuously aligned fibres. Metal-matrix composites are used in structural applications, and in applications requiring wear resistance, thermal management, and weight saving, and have been adopted in aircraft components, space systems and high-end sports equipment. The scope of applications will increase as manufacturing costs are reduced, although in motor racing they have been banned in several forms.

There is a plethora of new materials waiting in the wings for production costs to descend out of the Expensium range, such as Fullerites – the solid-state manifestation of fullerenes and related compounds and materials. 'Ultrahard fullerite' is a coined term frequently used to describe material produced by high-pressure high-temperature (HPHT) processing of fullerite. Such treatment converts fullerite into a nanocrystalline form of diamond which has been reported to exhibit remarkable mechanical properties.

As always, the desirability of anything new has to be tempered with the real gains made in stiffness, lightness, ease of use and cost. All too often, the perceived sexiness of a fashionable material can thwart good engineering.

Carbon fibre reinforced ceramic, ubiquitous, omnipresent, sexy, but 'every path has its puddle', or – as Dante said – *Necessità 'l ci 'induce, e non diletto*. (Necessity brings him here, not pleasure. – *Inferno* Canto XII, line 87.)

It all comes back to a truism: Racing costs today exactly the same as it did 20 years ago. It takes every penny you have.

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Competition engine components have to withstand high stresses and fatigue levels, particularly in race conditions.

OvaX high performance steels from Ovako are designed for motorsport applications, combining high cleanliness with durability in order to achieve the best performance at peak operating levels.

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Produced via a highly sophisticated melting and refining process OvaX alloy steel is extremely pure with high oxidic cleanliness, free from impurities. Such is the material quality that it can often be used to replace re-melted steels, offering reduced delivery times.

In order to achieve this Ovako refines its ingot casting process. The production process utilises an operation that modifies the inclusion morphology within the material, ensuring a lower number of elongated sulphides, extremely low sulphur content and reduced size and distribution of oxides. Micro segregation within the material is further reduced by increasing the soaking time and top cropping. As a result, the finished material has an excellent isotropic profile demonstrating toughness and fatigue strength with identical properties in both longitudinal and transverse directions.

The desirability of anything new has to be tempered with the real gains made in stiffness, lightness, ease of use and cost

Different, not difficult

The racecar simulation process from start to finish

BY DANNY NOWLAN

Over the last couple of months I've seen a lot of inquiries coming my way from prospective ChassisSim users. It's been a very exciting time, because it's great to see people taking racecar simulation seriously and thinking about how it can slot in to their existing race programs. But a common theme I have seen is that they usually don't know where to start. Once they get going, most novice users don't have a clue what to do. This is what we'll be addressing here.

One of the greatest misconceptions I hear about simulation is that it has a reputation of being too hard. This is something that I've heard since the birth of ChassisSim back in the mid '90s, and I'm telling you right now it is rubbish. Simulation isn't hard – it's just different to what you are used to. If you accept this, simulation becomes a lot more straightforward and all you need to do is learn how to connect the dots. If you do this, the results will take care of themselves.

The first step in the process is to measure up the racecar and get it on some scales. If you're serious about your racing this is a must-do job. If you can't be bothered to do this, I hate to say it but O.P.B (Other Professions/Past times beckon). I have written a number of articles on the topic, but there are a few things that I want to touch on. These are techniques that I have used in the past that have been of great assistance to me when I've had to get results from nothing in a hurry.

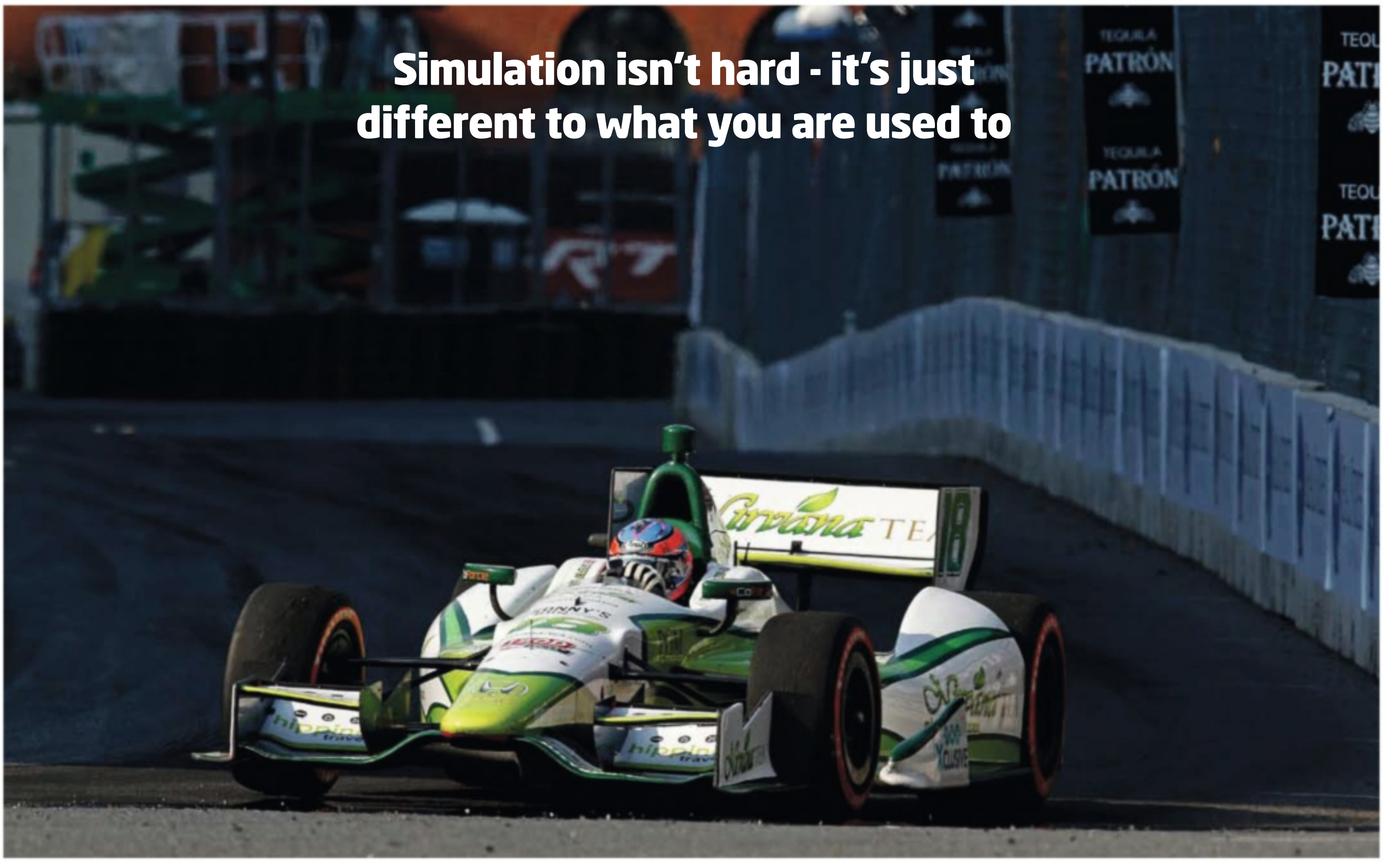
The first point I want to cover is measuring suspension geometry. This is one of these jobs that a lot of people assume is really difficult. It actually isn't, it you just need to be patient and thorough and be systemised about the references you are using. Let's continue our discussion by measuring the car on our setup pad. A really effective shortcut I have found for a symmetric car is the little worksheet illustrated in **Figure1.**

All the dimensions here are in mm. For convenience – and to make the picture easier to read – I've omitted pushrod locations, steering arms, etc. What makes this effective is that because you are measuring the points across you get a very good measure, and you also cut down inaccuracies: to get the y co-ordinates, all you have to do is divide by two. By measuring the points to an obvious reference (in this case the front bulkhead and the ground) it cuts out a great deal of error.

A useful thing I like to do is, when measuring suspension geometry, to keep WinGeo, SusProg, or the ChassisSim suspension geometry calculator, open. When I've made my first cut of measurement, I plug in the co-ordinates and see what the geometry looks like. For ease of illustration I've used the ChassisSim suspension geometry calculator, which can be seen in **Figure 2.**

Typically I'll hit analyse configuration. If I have screwed up, the calculated values will look really silly. If the numbers are funny that's your cue to re-measure the geometry.

The next thing to touch on is measuring the centre of gravity height. I've seen a lot of different methods, but in my experience the most successful approach is to prop the car on its side until it is perfectly balanced. This is illustrated in **Figure 3.**



You do not get brownie points for being a hero and proving how clever and brilliant you are

The centre of gravity height in the symmetric car case is given by **Equation 1**:

$$h = (0.5 \cdot tm + t\_off) \cdot \tan(90 - \phi)$$

Here we have the following:

h = Centre of gravity height
tm = Mean track of the car. This is the effective track at the centre of gravity.
t_off = This is typically half the tread width, but a little bit more if the tyres are cradled by angle iron.
ϕ = The angle the car is making to the ground as shown in Figure 4

Before you all baulk at this technique, I've seen this done on a 1500kg stock car. The trick is to pump the tyres up and use a bit of angle iron to cradle the tyres.

The last thing I want to discuss is measuring motion ratios. This is something that you mess up at your peril and personally, I think you are stark raving mad if you don't do it. The goal is to measure wheel and damper movement from full droop to full bump of the wheel. The goal is to plot damper movement vs. wheel movement, using Excel to tell you the motion ratios. What I do want to touch upon is a really useful technique for doing this, which is shown in **Figure 4.**

The process is really simple. You get the car in the air, as illustrated. You disconnect the bars and take off the springs and bump rubbers. Just before you get the car in the air, take a marker and draw on the damper where it is on the ground. It's good to have as a reference, particularly if you want to plot motion ratios relative to the ground. Then all you need to do is get a car jack, measure the wheel movement to a fixed level (as illustrated by the table), and measure the compression of the dampers. Do this with Excel open and input the numbers as you go. Then repeat the process for the bar movement. I have lost count of the number of times I have used this method and it is bullet-proof.

The next step is to record the vehicle setup for a particular outing. What I mean by the vehicle setup is the combination of springs/bar/dampers, wings gear ratios that you were using. In particular this is what you are after:

- **Spring rates, bump rubber force displacement curves and bump rubber gaps**
- **A peak force vs velocity curve for all the dampers**
- **The current suspension geometry configuration**
- **The gear ratios you were running and rolling tyre radius**
- **Cambers and toes**
- **An engine power graph (or at least peak power and min and max rpm)**
- **Ride heights**
- **Wing configuration**

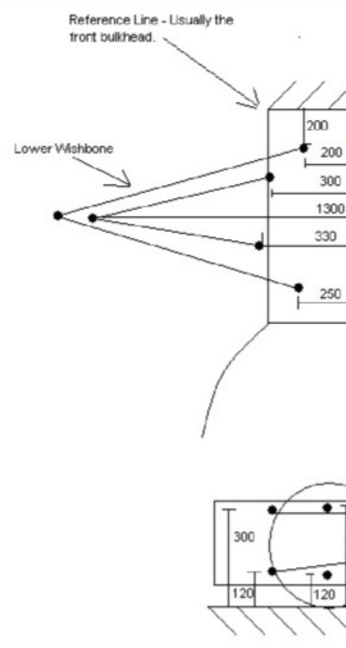


Figure 1: Suspension Geometry measure sheet.

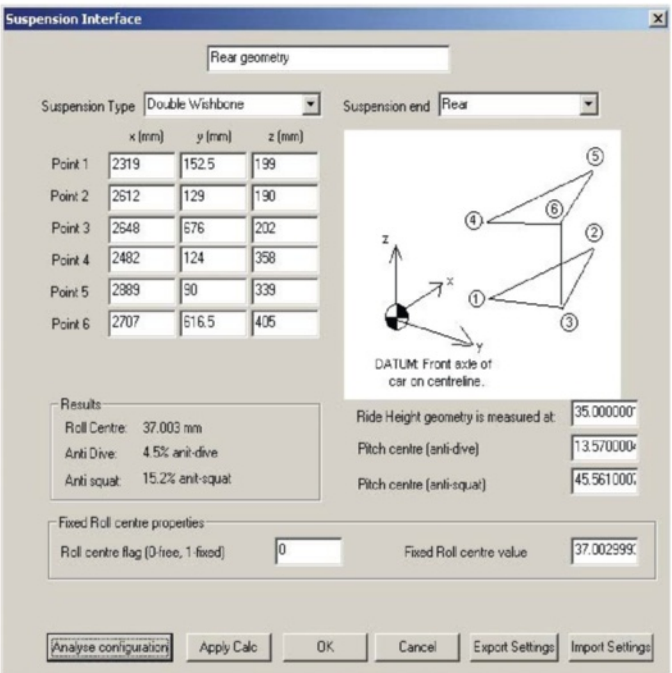


Figure 2: ChassisSim suspension geometry dialog with suspension geometry calculator

The bulk of this information should be on the car setup sheet, and the rest is easy to obtain.

The next step is to get the data set for that particular outing. You will need this to perform your correlation and any necessary vehicle modelling work that you need to do. The list of channels you need is the following:

- **Lap distance in m (to two decimal places)**
- **RPM**
- **Lateral and Longitudinal g – make sure the lateral g signal is zeroed and double-check the Longitudinal g channel makes sense**
- **Damper displacements. These should be positive in bump and zeroed on the ground**
- **Steered angle. Degrees at the tyre and zeroed**
- **Throttle**
- **Speed - make sure this is filtered**

A nice bonus is tyre loads, which should be zeroed on the ground. It should be noted that, depending on your sim package, all of these are in SI Units. I can not overstress the importance of double-checking these channels with the comment items I have provided. What I have just outlined is the creation of what we at ChassisSim call the monster file. If you get it wrong you'll be struggling, so do it right. A good friend and colleague remarked that a good monster file is next to godliness!

Once you have all the data in place it is time to create a vehicle model from an existing template. I can not emphasise this point enough: you do not get brownie points for being a hero and proving how clever and brilliant you are, particularly when you are a beginner.

Start from an existing template because chances are it's already very close and all you will need to do is put in the particulars of your setup into the model and save the file in a different location so you don't overwrite it! For example, when I created the IndyCar template

The simulation process is not rocket science. It is attention to detail and involves working methodically and systematically

in ChassisSim I simply took the existing GP2 model and made small tweaks to get it close.

The next step in the process is to run the model to check it is functional and nothing is amiss. I would strongly suggest taking the monster file, generating a smooth circuit file, and running this with no bumps. At this point in the process you are not looking for the world's most perfect correlation. What you are looking for is to make sure you are in the ballpark. At this point, the correlation you are looking for is shown in **Figure 5.**

As always, the actual car is coloured while the simulated car is black. As you can see, the speed trace isn't spot on, but the roll and pitch (as indicated by the damper traces) are close. What this shows is that our motion ratios are in the ballpark and our downforce and drag aren't that far off. Bottom line, this will show you if there are any serious problems you need to rectify in the model. This is particularly apparent with regard to motion ratios, where you will see a big difference in the combined damper movements. If you see something like this, double-check the motion ratios.

Once we have our initial correlation we have two forks in the road. If the grip and damper traces do not correlate, run tools such as the tyre force estimation feature and the one-touch aero features in ChassisSim to come up with an initial estimate of the two parameters. If you have the sort of correlation shown in Fig.5, your next step is to dial in the downforce and drag to ensure these parameters are where they need to be. The best measure of this is what the damper and speed correlation look like at the end of the straight.

The next step in the process is to create the circuit model. What I'm about to say is unashamedly ChassisSim-specific, since in my view it gives you the best view of what the car will encounter. What you have to do is the following:

- Create the bump profile and run the simulation
- Dial the tyre global grip factors to get you in the ballpark. As a rough rule of thumb, I increase the grip factor by 20 percent over a smooth model
- Dial in the bump scale factors to dial in big corner speed differences. Focus on the turn in to mid-corner section
- Refine with grip factor. Focus on the turn in to mid-corner section

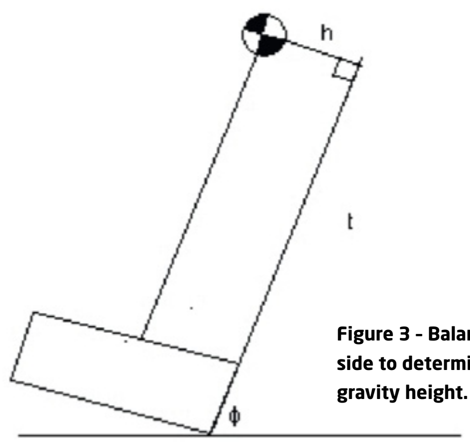


Figure 3 – Balancing a car on its side to determine the centre of gravity height.

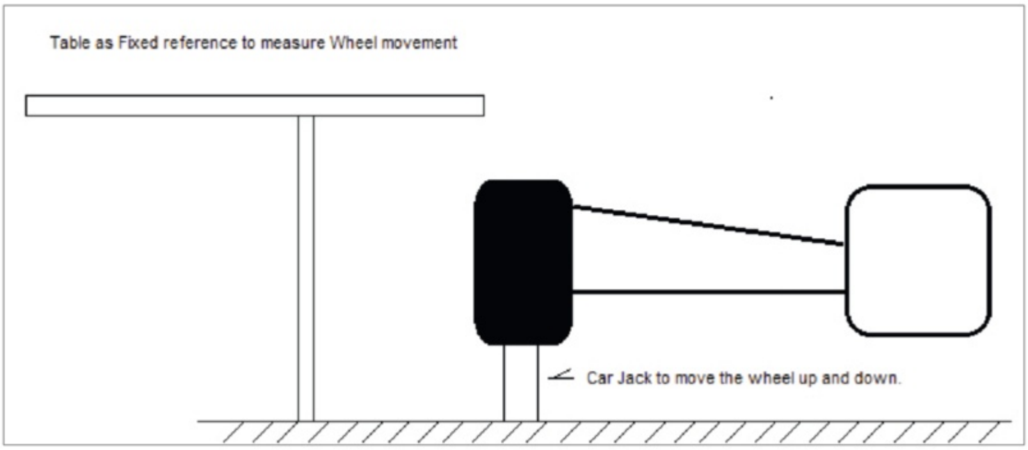


Figure 4: Measuring motion ratios

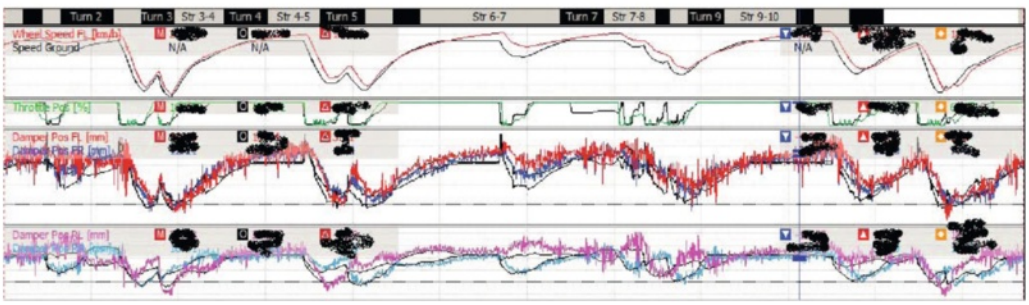


Figure 5: Initial correlation run

The subject of circuit modelling is an article in and of itself, and a topic I will return to later. What I will say is that what has been presented here is proven. Ignore it at your peril.

Having reached this point you have a model that you can start to use for some rough sensitivity analysis. It will give you gear ratios, help with wing selections and give a rough guide on springs, bar and dampers. Don't do big global changes at this point. Focus on small sensible changes. Log your data, treat it like a test session and look for small sensible changes in C-Time.

To complete the model, refine the aero model and work through the tyre force modelling process. Here we are primarily focusing on the steps you need to follow, not the details, but do the aero modelling first, followed by the tyre force modelling. Now you have a full fire-breathing model that can be used in anger and which can be used to win races.

The simulation process is attention to detail and involves working methodically and systematically through the steps described here. In summary, all you are doing is measuring up the car, noting the setup, preparing the data, generating the model from an existing template, dialling in the parameters and then creating the circuit model and refining it from there. It's as simple as that. Also, what we have discussed is not theoretical. This is practiced through the ChassisSim community in senior formulae over three continents.

Formula 1 revenues on the up thanks to television revenues

Financial statements recently filed at the UK's Companies House show that F1 continued to thrive throughout 2012 as new TV deals and added races helped to generate extra revenue.

Formula One World Championship Limited reported a rise of some 12 per cent in revenues, with a staggering $1.35bn going through its tills, a significant increase on the $1.2bn it raked in in 2011.

The championship, which operates as Formula One Management (FOM) under a number of parent companies including SLEC Holdings, Delta 2 and Delta Topco – and is ultimately owned by CVC Capital Partners – says the increase in revenue is largely down to two extra races, and also new TV deals such as the BSkyB TV tie-up in the UK.

The directors' report stated: 'Strong growth in revenues was driven by the effect of the change to the championship calendar in 2012 which saw strong incremental revenues generated from the events in the USA and Bahrain [the latter was cancelled in 2011 due to political unrest], growing logistics revenues as a result of two additional fly-away races … the benefits of revised TV rights arrangements in the UK, growth in fees earned from the Group's technical and broadcast origination activities, and underlying contractual uplifts in other TV and race promotion agreements.'

Increased television revenue has helped to boost the 2012 F1 takings

Before payments were made to the teams, F1's earnings before interest, tax, depreciation and amortisation (EBITDA) were $1.2bn ($1bn in 2011), with the 20 races of 2012 each generating an average of $59m.

On top of this, Formula 1 also makes money from its trackside advertising and hospitality businesses, reckoned to be in the order of $395m – although as both of these companies are based in Jersey accounts are not publically available.

As for the teams' cut, the statement says this totalled $752m in 2012, which is eight per cent higher than 2011 ($698m), and three times the amount paid in 2007, when the last Concorde Agreement was signed.

Despite the fact that it was widely reported that a new Concorde Agreement was signed following the Singapore Grand Prix, this was only a bilateral agreement between the FIA and Formula 1 boss Bernie Ecclestone, and did not include the teams. However, all the teams (excepting Marussia) have now individually agreed prize fund money with Ecclestone until the end of 2020.

NASCAR track operator: more revenues but larger loss

International Speedway Corporation (ISC) has posted an increase in revenues for the third quarter of 2013, but also a larger net loss when compared to the same period last year.

ISC, which is NASCAR's track operating arm, reported $117m in total revenues for the three-month period that ended 31 August, up from $115.9m in the third quarter last year. It also reported a net loss of $7.9m, compared with a net loss of $1m for the same quarter in 2012. Much of this loss has been put down to initial expenditure on Daytona's multi-million dollar redevelopment.


Chicagoland: one of International Speedway Corporation's premier venues

LAT

For the fiscal year-to-date ISC has now generated $424m in revenues and a net profit of $28m, compared with $422.9 million in revenues and a net profit of $29.8 million for the same period last year.

ISC chief executive officer Lisa France Kennedy said she was satisfied with the results, and particularly with a slowdown in a recent trend that has seen a fall in takings from race-day attendances: 'We remain encouraged with our quarter and year-to-date financial results, generating increased total revenue for the periods. Adjusting for comparable events, our attendance revenue, which has been our principal risk, was down less than one per cent for the quarter, delivering results within our range of expectations and showing further signs of stabilisation in our business,' she said.

France Kennedy added that she was upbeat about the future of the company, particularly in the light of recent NASCAR TV deals, from which ISC will take a cut. 'During the quarter, we realised a number of significant objectives that puts ISC in a much stronger position for the long-term. NASCAR signed the largest broadcast rights deals in the sport's 65-year history, providing ISC contracted revenue through 2024. With broadcast revenue representing our largest revenue source, almost 50 per cent of total revenue, having this visibility through 2024 places us in an enviable position compared to other industries and will provide us unparalleled long-term cash flow.'

Engine deals for Formula 1 2104 completed

Almost all of the Formula 1 engine deals for next season have now been completed, with Sauber and Caterham signing up with Ferrari and Renault respectively, leaving only Lotus still to confirm its supplier, widely expected to be Renault.

Sauber's re-signing with the Scuderia means the Swiss squad goes into its fifth season using a Ferrari power-plant – it also used Ferrari power from 1997 until the end of 2005, before BMW bought the team. The team, which split with BMW when the German manufacturer pulled out of F1 at the end of 2009, has described the Ferrari deal as a 'multi-year' arrangement.

Sauber team principal Monisha Kaltenborn said: 'We are proud to extend our relationship with such a prestigious and renowned brand and look forward to entering the 2014 season with a strong and reliable partner like Ferrari.'

Meanwhile, Caterham has inked a deal to remain with Renault for 2014. Cyril Abiteboul, Caterham team principal, said: 'The 2014 season heralds a new era for F1 with our sport taking a positive stance in aligning itself with the technical changes in the global automotive industry, and Renault is right at the cutting edge of that development.

'When our F1 partnership began in 2011 we, as a young team, were immediately impressed by the various benefits of the collaboration on our operations, and since then we are relentlessly pushing them even further. Given the age and status of our team we have also been pleased to see Renault Sport F1 adapting their operational practices to suit our size and optimising our integration with an enhanced technical collaboration.'


LAT

Crowds thrill to Renault, Mercedes and Ferrari power

The full car-engine line up for 2014's new V6 turbocharged formula is: Ferrari, Sauber and Marussia (Ferrari engines); Mercedes, McLaren, Williams and Force India (Mercedes) and Red Bull, Toro Rosso, Caterham and Lotus (Renault) – although the Lotus-Renault partnership awaits confirmation.

LAT

British Formula 3 moves to reduce costs

The British Formula 3 Championship is to re-position itself as a low-cost feeder series for the FIA European Championship as it looks to attract more competitors after a truncated season in 2013.

SRO Motorsports Group, the body that promotes British F3, has announced a new seven-round national championship – which features a return to the ultra-quick Thruxton circuit – with six rounds in the UK and only one abroad, at Spa. This year the British Formula 3 Championship was reduced to just four triple-header rounds after teams found it difficult to fill seats.

The championship intends to run with the current engine regulations next year, while the European Championship will move to the new 2014 engine formula. British runners will have the option of using the older chassis, the Dallara F308, or the F312.

British-based F3 teams have responded positively to the news, and crack outfits such as Double R Racing, Carlin and T-Sport have all said they would be interested in running a British campaign alongside their European programmes. However, for this to happen team bosses have also said it would be important that there were no date clashes.

Russell Eacott, T-Sport boss, told *Racecar Engineering*: 'Obviously we'd like to do it because it's the British championship; if there are drivers available we've got cars and engines that we can run, so yes we would like to do it and we are talking to some drivers. I think that if they can get a calendar together that doesn't clash with the FIA it could work, and I think this is key.'

A budget for the new British Championship should be around the €250,000 to €300,000 mark, we're told, equivalent to a Formula Renault campaign in mainland Europe, while the FIA European F3 Championship commands budgets of around the €600,000 mark.

Stephane Ratel, founder and CEO of SRO Motorsports Group, said: 'We will use the current 2013 FIA engines and run with both the Dallara 308 and 312 chassis. With lower budgets for a six-race [now seven] national championship, it will position the British F3 Championship as a feeder series to the FIA Formula 3 European Championship and guarantee healthy grids.'

The British championship confirmed it is keeping its Cooper Tires title sponsorship, which will also be the series tyre supplier.

Jaguar and the University of Warwick in £100m tie-up

Jaguar Land Rover has announced plans for a £100m advanced research and development centre to be located at the University of Warwick.

The National Automotive Innovation Campus (NAIC) has been designed to create a large-scale collaborative research environment and will feature engineering workshops and laboratories, advanced powertrain facilities and the latest advanced design, visualisation and rapid prototyping technologies. Jaguar Land Rover hopes the centre will bring academics from the UK's leading universities together with researchers and engineers from Jaguar Land Rover and its supply chain in a single, state-of-the-art research facility.

Jaguar Land Rover is the lead partner in the project, investing £50m, along with Tata Motors European Technical Centre (TMETC), WMG (Warwick Manufacturing Group) and the UK Government's Higher Education Funding Council England (HEFCE).

Construction of the NAIC – which is expected to cost close to £100m – is scheduled to begin in September 2014. Around 1000 academics, researchers, technologists and engineers will work in the building.

Antony Harper, Jaguar Land Rover's head of research, said: 'We will announce the details of the specific research projects on which our NAIC research team will collaborate in due course, but these will be long-term, multi-disciplinary challenges – such as electrification, smart and connected cars and Human Machine Interface – which will help us create some key new technologies that will deliver a low-carbon future.'

The development of the NAIC project is the next stage in Jaguar Land Rover's long-term research strategy, and the company says it will build on the success Jaguar Land Rover has enjoyed as part of its long-standing relationship with WMG at the University of Warwick.

Nearly 200 Jaguar Land Rover researchers and engineers are currently based at WMG. Jaguar Land Rover expects that it will more than double the size of its advanced research team to 500 people by the time the NAIC opens in 2016.

NASCAR confident of finding replacement for Nationwide

NASCAR says it is sure it will find a blue chip company to step into the breach left by the withdrawal of Nationwide as the title sponsor of its second-string race series when the Sprint Cup deal expires at the end of next season.

Nationwide will remain involved with NASCAR, focussing on individual programmes in the Sprint Cup from the 2015 season onwards. Nationwide has sponsored the second division NASCAR series for the past five years, having taken over from beer brand Busch at the end of 2007.

NASCAR is now looking for a replacement for Nationwide, and its vice president and chief sales officer Jim O'Connell told *USA Today Sports* that this could be either a current NASCAR sponsor or one completely new to the sport. He also said he was 'very confident' a new sponsor would be in place by the start of the 2015 season.

'This is a phenomenal asset,' O'Connell said. 'It's unrivaled integration and ownership. We anticipate speaking to a number of Fortune 500 companies that will be interested. Nationwide showed NASCAR is a great place for business. We're very confident at the beginning of 2015 we'll have another great partner on board as the series entitlement sponsor.'

O'Connell also said that NASCAR was not focused on any particular business sector as it searches for a replacement backer. 'It's not necessarily categories but more the right kind of partners that will activate the way Nationwide did and embrace the sport,' he said. 'It's more about partners and marketing plans and how they can grow the sport.'

Nationwide chief marketing officer Matt Jauchius said of the company's involvement: 'The NASCAR Nationwide Series is a great proving ground not only for drivers and crew members, but for sponsors. We're proud of the success Nationwide Insurance has attained through our relationships with NASCAR and the Nationwide Series.

'It's a natural evolution for Nationwide Insurance to move our marketing investment to the NASCAR Sprint Cup Series, and we'll continue to put tremendous effort behind all of our NASCAR marketing platforms in the years to come.'

LAT

BRIEFLY

UK F4 out to tender

The MSA, the UK governing body for motorsport, is to sanction a British F4 Championship in line with the FIA's new plans for a carbon-chassis global starter formula – not to be confused with the current spaceframe F4 run by MSV. The job of organising and promoting the championship has been put out to tender; requirements include a €100,000 budget cap and a one-make chassis cost-capped at €40,000. Turbocharged engines will now be allowed.

Innovation shortlist

The shortlist for the Society of Motor Manufacturers and Traders Award for Automotive Innovation for 2013 has been released. The prestigious award is now in its fourth year and recognises 'exceptional innovations that have the potential to transform the industry'. Listed this year are Ford, for its EcoBoost 1-litre three cylinder engine; McLaren Automotive for its P1 supercar and Zircotec, for its Thermohold thermal coating technology.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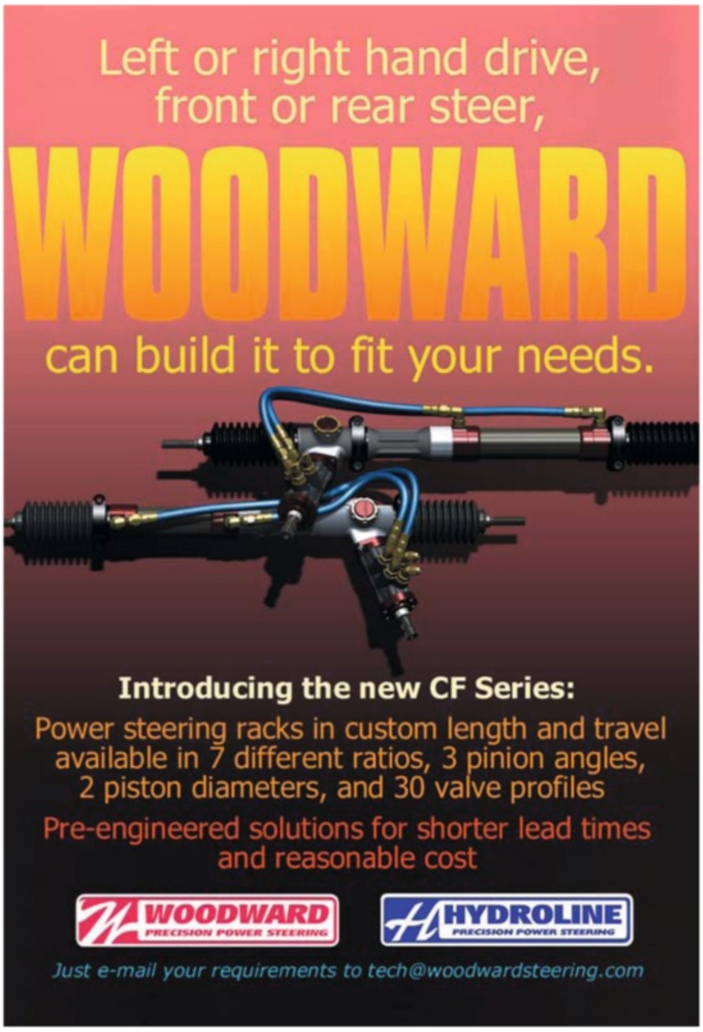
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McLaren posts 2012 losses as Mercedes split starts to bite

McLaren Group Limited has said that its changing relationship with Mercedes is partly responsible for it posting a loss for the year ending 2012.

The Group's recently-filed financial statement shows that it made an operating loss of £2.5m in 2012, which compares unfavourably with a £23m operating profit the previous year. McLaren says this is partly down to the change in the nature of its tie-up with Mercedes – it is now an engine customer rather than a Mercedes-backed team – as well as its greater F1 spend.

McLaren, which will race with works Honda engines from 2015, said of the loss: 'This deterioration in profitability is as a result of the changing relationship with our former shareholder Daimler, together with an increased spend on our F1 activities including increased driver costs, increased number of races and costs associated with operating wind tunnel testing away from our headquarters.'

The Group's 2012 turnover was £249m, up £10m from £239m the previous year. It describes its activities as: 'participating in motor racing events throughout the world, designing and constructing engine management systems, data-logging equipment and electronic products [through its technology businesses McLaren Electronics and McLaren Applied Technologies] hospitality services and on-site catering, and the provision of marketing and advertising services.'

A breakdown of the group's business activities shows F1 racing turned over £211m, marketing £24m, engine management systems and manufacture £26m and application of developed technologies £27m.

LAT

Lewis Hamilton drives the MP4-27

THE GRID

Formula 1 workforces: head counts at F1 operations

1. Mercedes: 930	
	2. Ferrari: 700
3. Red Bull Racing: 690	
	4. McLaren: 600
5. Williams: 520	
	6. Lotus: 500
7. Sauber: 320	
	8. Toro Rosso: 300
9. Force India: 300	
	10. Caterham: 260
11. Marussia: 220	

Note: *McLaren and Ferrari are estimated and the latter includes the engine operation. Mercedes includes staff at Stuttgart (30) and High Performance Engines (400)*

Auto GP to bring back prize money

Top level international single seater championship Auto GP is to reintroduce prize money from next season.

Its new prize fund structure will see the leading three point scorers over each double-header race meeting sharing from a pool of around €300,000 across the season. There has been no prize money this year – as the series has invested in updated racecars – but Auto GP offered €245,000 in 2012, while in its original season (2010) there was as much as €100,000 per weekend – largely thanks to a generous sponsorship deal that was then in place.

Enzo Coloni, the former F1 team boss and the man who runs Auto GP, said part of the reason for bringing back the prize fund was because of a growing demand from teams hoping to compete in next year's championship.

'Auto GP is currently the only championship to provide its most deserving drivers with race-by-race prize money for 2014,' he said. 'We started our prize money programme in the earliest stage of our history, and as requests to bring it back, especially coming from the new teams, was quite high, we decided to re-introduce the programme.'

Auto GP started life as Italian Formula 3000 in 1999, and was known as Euro Formula 3000 and Euroseries 3000 before taking on the name Auto GP in 2010, the year it swapped its old F3000s for the first generation A1 GP Lolas, updated versions of which it still uses.

CAUGHT

Jeremy Bullins, the crew chief on the No.22 Penske Racing Ford in the NASCAR Nationwide Series, has been fined $10,000 after the car was found not to meet the minimum front ride height at the Dover round of the series. Car owner Roger Penske was docked six points in the owners' championship as a result of the infraction.

FINE: $10,000
PENALTY: six points

McLaren Applied Tech' opens new Asian HQ

McLaren Applied Technologies, the division of the McLaren Group which applies F1 know-how to industries outside of the sport, has announced that it has established the headquarters of its Asia Pacific operations in Singapore.

The announcement was made ahead of the 2013 Singapore Grand Prix and the new HQ will be the first registered MAT office outside the UK.

MAT says that with a large number of multi-national high technology companies located in Singapore it is expecting to significantly increase its client base in the country, and wider region, in the years to come. It added that Singapore is an attractive location because it has a business-friendly environment and an extremely strong education system, which produces a consistent supply of talented scientists and engineers.

MAT Singapore will act as a hub, supporting the company's entire Asia Pacific operations, enabling it to expand its business across the fast growing region, the company says. Dr Geoff McGrath, MAT managing director, said: 'We have a number of well-established partnerships with blue chip companies that are based in Singapore or who have major operations here. There are also strong prospects for future growth in the country and the wider Asia-Pacific region as we begin to develop new relationships with some of the exciting, cutting edge companies operating everywhere from Japan to Australia. [This] announcement will open up further opportunities for growth and marks an important milestone in the development of MAT as a global technology company.'


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Electric LSR for Drayson Technologies

Lord Paul Drayson has set a new World Electric Land Speed Record over a measured quarter mile from a standing start, setting a time of just 9.742s, reaching a top speed of 93.383mph over the distance.

Over the measured mile, the all-electric prototype achieved a two-way average speed of 205.139mph, and 333.271kph over the measured kilometre (subject to FIA homologation) on the 3km Elvington runway.

The car reached an unofficial maximum speed of 219.1mph/352.6kph during the runs in windy conditions, according to GPS data. The speed also represents a new British LSR over the measured mile for cars of any propulsion type driven by their wheels.

'The engineering challenge of accelerating a 995kg electric car to these speeds and then stopping in time on such a short runway is pretty intense, but it's a great proving ground for our technology,' said Drayson. 'It's also an exciting way of demonstrating what's possible with a state of the art electric vehicle.'

Plans to test the car to its full speed potential on the 15-mile track at Bonneville Salt Flats in September were postponed due to flooding.

MWR to reduce NASCAR Sprint Cup effort

On 14 October, Michael Waltrip Racing officially announced that they will scale back from three NASCAR Sprint Cup teams to two in 2014. At the same time, they informed more than 40 employees that they would be released from their contracts at the end of the year.

The shrinkage is necessary because of the departure of sponsor NAPA, due to the fallout from issues created by the team at Richmond Raceway in which they changed the outcome of the race and the championship Chase.

In addition, MWR general manager Ty Norris has been moved to the position of director of business development. Norris was heard on the radio instructing one of their cars to pit during the 'Richmond Gate' incident and as a consquence he has been suspended from NASCAR events indefinitely.

Six NASCAR Sprint Cup teams tested three different aero packages at Charlotte Motor Speedway on 14 October in a test conducted by NASCAR to determine possible packages for 2014. Ride heights, front splitter ground clearance and rear spoiler heights were assessed during the full day test, the first of a series of ongoing tests in an effort to improve the racing package for next year.

SPONSORSHIP

Watch brand **Tudor** is to be the title sponsor of the new for 2014 **United SportsCar Championship,** having signed a five-year deal with the series. Tudor is a **Rolex** brand and the parent company is a long-time backer of GrandAm. Rolex will also continue to serve as title sponsor of the US endurance classic, the Rolex 24 at Daytona.

NASCAR Sprint Cup team **Michael Waltrip Racing** is to lose its **NAPA** sponsorship for 2014 in the wake of the Richmond race fixing scandal, where the team was fined $30,000 after it was adjudged that it tried to manipulate the finishing order. 'NAPA believes in fair play and does not condone actions such as those that led to the penalties assessed by NASCAR. We remain supportive of the millions of NASCAR fans and will evaluate our future position in motorsports.'

Quicken Loans is to be the primary sponsor on the No.31 Richard Childress Racing car for 12 races in the 2014 **NASCAR Sprint Cup Series.** The deal has arisen because driver Ryan Newman is to move from **Stewart-Haas** racing to **RCR** next year to drive the No.31 Chevrolet, and he will take his backing with him. The financial company has sponsored Newman since last season.

IndyCar is to lose its **IZOD** title sponsorship at the end of this season. Mark Miles, chief executive officer of **Hulman & Co,** the parent company of IndyCar, said: 'We are proud of our partnership with IZOD over the past six years and we're grateful to **PVH Corp,** owner of the IZOD brand, for its support, creativity and vision.'

BRIEFLY

Instant return

Volvo's decision to race in the V8 Supercars championship next year with a version of its S60 model has already paid dividends, according to Volvo Car Australia managing director Matt Braid, who told the championship's website that sales of the model in Australia have already started to pick up, even though the cars have not yet hit the track. Volvo's V8S campaign, which was announced back in June, is to be spearheaded by Gary Rogers Motorsport (GRM). GRM is to swap its current Holden Commodore VFs for S60s, the first of which is now being built at the team's base. The car will be powered by a 5.0-litre version of the Volvo B8444S engine, developed by Swedish Volvo specialist Polestar Racing.

Mont-E Carlo

The provisional calendar for the inaugural FIA Formula E championship for electric racecars has been released, with an event at Monaco in the same month as the principality's grand prix now on the schedule, although a much-vaunted race through the streets of Rome has not made the list. The schedule, which is subject to track approval by the FIA, is: Beijing (20/9/14); Putrajaya, Malaysia (18/10/14); Hong Kong (8/11/14); Punta del Este, Uruguay (13/12/14); Buenos Aires (10/1/15); Los Angeles (14/2/15); Miami (18/4/15); Monte Carlo (9/5/15); Berlin (30/5/15) and London (27/6/15).

F1 tests too costly

The return of in-season testing will hike F1 budgets by as much as £10m, with Force India team manager Andy Stevenson admitting to an £8m price tag that could preclude their involvement in the tests. 'We think there is going to be quite a large cost implication, especially in the way that we run our team, and with the resources we have available to us now, it won't be possible for us to attend the four tests as planned,' he said.

BUSINESS INTERVIEW - GERARD QUINN

An enthusiast at heart

Ford Europe may have cut back on its WRC presence, but it's still serious about its rallying and racing. We spoke to motorsport boss Gerard Quinn to find out more

Back in 1989, Gerard Quinn was a passionate motorsport fan working on the assembly line at Ford's Dagenham plant in Essex. He wanted nothing more than a job in the company's illustrious competition department and attended an interview with Stuart Turner about getting a place on the team. Sadly, the Irishman was unsuccessful.

But Quinn bided his time, and 20 years later he stepped into the role of Head of Ford Racing at Ford Europe – a similar position to that held by Turner in '89 – after working his way through the non-motorsport corporate ranks at the company. Now he is responsible for Ford's European motorsport activities, with Jamie Allison holding the equivalent post in the US.

In the US the major Ford programme is NASCAR, in Europe it's the World Rally Championship (WRC). Until recently this was through a works effort in conjunction with M-Sport – said to cost Ford £30m, although Quinn would not comment on this – but that all stopped at the end of 2012, when Ford pulled the plug. The reason for this was simple economics, says Quinn: 'It was a corporate decision. We decided to apply our resources, and that's people and money, elsewhere. Product really is where we need to be right now, to sustain ourselves in the market place, and that's what we're doing.'

It was not the end of Ford's rallying involvement, but a change to the nature of that involvement. 'We're still heavily involved. Our involvement in WRC decreased in that we no longer have a team, a sponsored team, but we support privateer programmes around the globe. Our partnership with M-Sport also still continues, and we value the partnership, in that it is not just about WRC, it's about rallying – it goes from grassroots right up to the professional levels. What it means to Malcolm [Wilson, M-Sport boss] is that his organisation has access to our intellectual property, our remarkable technology; while we are also continuing to develop engines together for rally applications.'

His rationale is to ensure that the motorsport Ford is now involved in is relevant to the product it sells

This also means Ford is continuing to commit resources and is still spending money on the sport. 'As a manufacturer we're still responsible for homologation of the rally car. That is a key thing that people forget. We are a manufacturer recognised by the FIA, and it is only a manufacturer that can homologate. For example, the Fiesta R5 [to the new cost-capped WRC2 formula], homologation for that wouldn't have happened unless we committed and went through the pains of homologation, and obviously the payment of homologation, because the FIA likes its money.'

At the time of Ford's announcement to cease sponsoring M-Sport Quinn said 'a lot would need to change' with the WRC before Ford considered a return. As things stand he does not think it has changed enough, and one of his major gripes is the lack of TV exposure, particularly in the UK – an important market for the Fiesta. Quinn contrasts this with Ford's sponsorship of UEFA Champions League football, where it gets 'tremendous exposure by association'. Incidentally, Quinn also admits that it's 'potentially true' that the publicity the Fiesta gets from the Ken Block Gymkhana videos is better than that which it gets from WRC...

But motorsport is still important to Ford; its heritage in the sport is huge, and the company remains active in a wide range of disciplines – everything from rallycross to touring cars – albeit through privateer teams backed by Ford rather than official works efforts. Justifying motorsport programmes can be tough. 'To build a compelling rationale is becoming more and more difficult, because I am competing with other areas where we get exposure, and of course the challenge now is even greater because it's different forms of media, particularly with the digital era, and social media; making our product known to more people is much easier.'

The way Quinn builds his rationale is to ensure the motorsport Ford is now involved in is relevant to the product

it sells. It's this philosophy of relevance that drives the company's single seater programme, which it uses to promote its EcoBoost engine, now in Formula Ford, but perhaps soon in F4.

'Turbocharging is the way for small petrol engines for the future,' says Quinn. 'One of the dispensations we have for Formula 4 – if we are successful in the tender – is to run the turbocharged 1.6-litre EcoBoost, and that is hugely important for us.'

Formula 4 is perhaps one of the more contentious aspects of Ford Europe's current motorsport strategy. Basically, it's planning on switching its current EcoBoost Formula Ford to the new for 2015 FIA Formula 4 in the UK. This depends on it winning the contract from the MSA, to be decided next year, but it will (probably) mean a loss of the Formula Ford name, a switch to carbon chassis from spaceframes (coming soon after the recent FF change to a winged car), and almost certainly a move to a spec formula.

It is perhaps the move to one-make chassis which is the most controversial aspect of this. After all, FF is one of the last remaining places for chassis constructors to ply their craft. But Quinn is certain this is the right way to go: 'We need to take these things into context. If you look at Formula Ford today, you could almost say it is a spec chassis, because while it is an open engineering type category, Mygale is almost the only chassis on the grid; there's just one Sinter out there.'

One thing is for sure: Quinn believes it is in Ford's interest to be a part of the new Formula 4, which he says will be the 'future of motorsport' at this level, and Ford's interest has to be his first consideration.

For now Ford is relatively content with its place in the motorsport world, says Quinn, but it is not complacent, and it's always on the lookout for new opportunities. 'I have reviews with our hierarchy in Europe and we look at trends, what's good for us, what's good in the market place. But the key thing is always this: what can we apply our technology to that will create a challenge, and make it worthwhile for us?'

Among the things discussed include WEC – 'but it's not something we're interested in right now' – and among the things to be ignored is Formula 1: 'We made a conscious decision to move out a long time ago, and returning is not a consideration that we have made in any of our strategic discussions since.'

But Quinn's involvement in motorsport is not all about high-powered marketing meetings, and on some weekends he can even be found marshalling at club level rallies in his native Cork. He does this for fun, but it has its uses, too. 'It's great to be able to put something back, but it's also a great way of keeping up with the sport and understanding it,' he says. It's somehow comforting to know that a man who makes decisions on the motorsport future of one of the world's great car companies remains an enthusiast at heart.

– Mike Breslin

RACE MOVES

Jody Egginton has been promoted from operations director to deputy technical director at the Caterham F1 team. Egginton was among the first people to join Caterham in 2009, as chief engineer. He moved from that role in late 2012 to the post of operations director, taking control of all the team's operations at its Leafield, UK base.

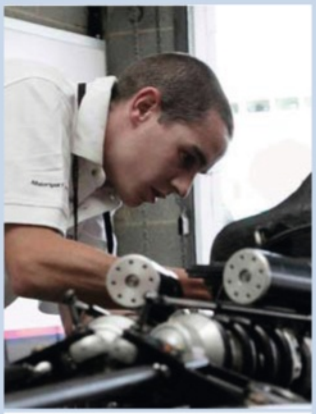
John Iley has seen his role at Caterham F1 broadened to include management of the new Advanced Projects Group, which is to look at future innovation that can be applied to the F1 team as well as all of Caterham's other automotive and technological interests. Iley will also now take a more active role, along with Mark Smith and team principal Cyril Abiteboul, in managing the technical partnerships Caterham F1 has with Renault Sport F1 and Red Bull Technology.

Doug George has taken over as crew chief at NASCAR Truck racing team Turn1 Racing for the remainder of the season. Former crew chief **Joe Shear Jr** has moved to Ken Schrader Racing, where he will take over and lead the 2014 Truck campaign for NASCAR K&N Pro Series East winner **Cole Custer.**

The decision on whether to try Formula 1 boss **Bernie Ecclestone** on bribery charges has now been delayed until next year. German prosecutors have postponed the decision because they are awaiting additional information from Ecclestone's lawyers, while the panel of judges presiding over the matter is also set to change. The Munich court has also decided it is best that the next step will not now be finalised until 2014.

Former Nurburgring boss **Walter Kafitz** has now left the Red Bull-Ring, the Austrian venue formerly known as the A1-Ring, which is back on the Formula 1 calendar for 2014. Kafitz was said to be instrumental in getting F1 back to the track, but his departure should not affect the 2014 Austrian Grand Prix, sources in the country insist.

Thomas Fatho has joined Falken Tyre Europe as its new marketing manager. Fatho's appointment follows the recent announcement of **Markus Bogner** as sales and marketing director. **Yukio Yoshida** remains in charge of the overall operational planning and development activities as corporate planning director. Fatho joins Falken from Mitsubishi Deutschland.



LAT

Tom White, of electrical systems provider DCE, has moved from the UK to work at the company's US production facility in North Carolina. White, who has been at DCE UK since 2006, has worked in a variety of motorsport disciplines during his time with the company, including F1, Indycar, NASCAR, ALMS, drag racing, Touring Cars, World Rally and Superbikes.

Lotus head of aerodynamics, **Dirk de Beer,** is to move to Ferrari for next season, where he will work alongside **Loic Bigois.** The South African's departure from Lotus to Ferrari marks the third major defection from Enstone to Maranello this year, with both technical director **James Allison** and driver **Kimi Raikkonen** also joining the Scuderia.

Ferrari chief aerodynamicist **Nicolas Hennel** is to move to Lotus. Hennel had been at Ferrari for just over a year, having previously worked at McLaren and Renault. The news that Hennel had been snapped up by Lotus came just a day after it emerged that de Beer was moving in the other direction to Ferrari (see above).

One-time ace Formula 1 race engineer **David Brown** – a man who engineered both **Nigel Mansell** and **Alain Prost** to F1 titles in the '90s – has now left GT outfit Krohn Racing, departing the team before the end of the World Endurance Championship season.

Former IndyCar team owner **Steve Horne** is the new chairman of the V8 Supercars Commission, taking over the role recently vacated by inaugural chairman **Mark Skaife,** who is moving to a more strategic

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OBITUARY – GEORGE BIGNOTTI

The man who prepared more Indianapolis 500-winning cars than any other chief mechanic in the race's history, George Bignotti, has died at the age of 97.

Bignotti was born in San Francisco and started his career in racing working on midget and sprint cars – following in the footsteps of older brothers Al and John – before arriving on the top level US single seater racing scene in the mid-1950s.

Cars prepared by Bignotti scored seven Indianapolis 500 wins, two of which (1961 and 1964) came with AJ Foyt (he also collected three USAC titles in four years with Foyt), while he also prepared the cars for the Indy 500-winning efforts of Graham Hill (1966), Al Unser (1970, '71) Gordon Johncock (1973) and Tom Sneva (1983).

Bignotti started his own team in 1980, running Marches, but sold it at the end of 1983 and returned to working as a chief mechanic. After retiring he continued to work in motorsport research and also as a spokesman for Mobil.

Indianapolis Motor Speedway president Doug Boles said. 'We're saddened to learn of the passing of George Bignotti. George is a true legend. He set a standard for mechanical excellence and preparation at the Indianapolis 500 that has yet to be matched and may never be reached.

'George's love and loyalty toward the 500 never waned throughout his wonderful, long life, and he had countless friends and admirers in Gasoline Alley and the IndyCar community.'

George Bignotti at the1974 USAC Indycar Series when he was chief mechanic for Gordon Johncock

George Bignotti 1916-2013

Mallory Park operator goes into administration

There is a question mark over the future of motorsport at Mallory Park after the company that runs the UK circuit was put into administration.

The move follows a long-running dispute over noise at the Leicestershire venue, which culminated in a large fine for the company that runs the track, Mallory Park Motorsport Limited (MPML), earlier this year.

Mallory is steeped in motorsport history – here's Jochen Rindt's Brabham BT10 in action in 1964

MPML, which ran the circuit on the behalf of the BARC, was fined £2500 and ordered to pay £23,000 in costs after being found guilty of operating outside the limits set down in its local planning agreement. It has subsequently failed to get an increase in the number of days on which it is allowed to operate.

MPML says the current operating conditions, which were set in 1985 and allow for a maximum of 44 race days plus its traditional Wednesday test day, make the venue financially unviable.

The news does not necessarily mean an end to racing at Mallory Park, and administrator Ian Robert has vowed to fight for a solution.

RACE MOVES

role within the organisation. Neil Crompton has also joined the Commission, in the position of independent commissioner, where he has replaced **Chris Lambden.**

John Grant has been elected to replace Stuart Rolt as the chairman of Silverstone owner the British Racing Drivers' Club (BRDC). Rolt had stepped down from the role after completing two three-year stints. Grant is a former chairman of the MSA and a successful historic racer. Outside of racing he was with Ford for 25 years, where he was head of corporate strategy in the US for a spell as well as the No.2 at Jaguar after Ford's purchase of the firm in 1990.

Dylan Napier, the team manager at the Tony D'Alberto Racing V8 Supercars squad, is to leave the team. **Graham Jenkins** will fill Napier's role at the final two races of the season, at Phillip Island and Sydney, but the team is now on the hunt for a new manager for 2014.

The Phoenix Racing Sprint Cup team has appointed veteran crew chief **Jimmy Elledge** to tend its No.51 Chevrolet until the end of the season. Elledge replaces **Nick Harrison** in the post. Harrison has moved to Richard Childress racing, where he is now crew chief on the No.33 Chevrolet.

Andrew Villa is to head up the new US office of specialist and motorsport insurance provider Ellis Clowes & Co. Villa, who is now the firm's chief operating officer, is well-known within the US motorsport scene. He will be responsible for setting up the new office, which is to be based in Rochester, NY.

NASCAR Sprint Cup outfit Furniture Row Racing has made substantial changes to its over-the-wall pit crew. The No.78 team now features four new members from the NASCAR Nationwide Series programme at Richard Childress Racing; it was able to do this as Furniture Row and RCR have a technical alliance. The new men are **Thad Wymer, Jake Lind, Brian Gainey** and **Josh Sobecki.**

Donald Davidson, the historian at the Indianapolis Motor Speedway, has been inducted into the Richard M Fairbanks Indiana Broadcast Pioneers Hall of Fame. Davidson has been a member of the Indianapolis Motor Speedway Radio Network team since 1965, and since 1971 he has been heard throughout the month of May with qualification coverage and the nightly *Talk of Gasoline Alley* call-in programme.

LAT

John Smeltzer, a crew member in the NASCAR Nationwide Series, has been indefinitely suspended from all NASCAR competition for violating the sanctioning body's strict substance abuse policy.

John Barnes, managing partner at IndyCar outfit Panther Racing, is to be presented with the Spirit of Hope Award, given annually to individuals who have helped the US armed forces. Barnes has been the driving force behind Panther Racing's partnership with the National Guard since 2008 and has created the 'Operation Hire Our Guard' employment programme, which seeks to help National Guard soldiers with unemployment issues.

McLaren Applied Technologies has announced the appointment of its first regional director for its Asia Pacific operations. **Kok-Leong Lim** has been promoted from within MAT and will take responsibility for the company's activities across the Asia Pacific region. He will be based in MAT's new Singapore headquarters.

Motorsport PR company Compelo has appointed **Paul Kingsley,** partner at Vivacity – a sport and lifestyle marketing consultancy – to its board, along with Progressive Media Group's managing partner, and former Team GB Chef de Mission for London 2012, **Andy Hunt.** The news comes as it was announced that Progressive Media Group – a privately held international group of companies that span media and business information services – has taken a significant ownership interest in Compelo.

■ Moving to a great new job in motorsport and want the world to know about it? Or has your motorsport company recently taken on an exciting new prospect? Then send an email with all the relevant information to Mike Breslin at bresmedia@hotmail.com

BUSINESS TALK: CHRIS AYLETT

Optimism beckons

Chris Aylett says that the good times are set to return

Once more we enter the infamous 'show period' and look forward to business at PMW, SEMA, PRI and *Autosport* International. I can't help but be impressed by the improvement in the economic figures that affect most of our important markets. The USA is having a general up-swing in employment, house prices and consumer spending, as are the UK and Germany. France and Italy are improving but more slowly, and those emerging markets of China, India, Russia and Brazil are showing continuing signs of good growth. This means sponsorship for motorsport is likely to return, as consumer spending means more brand activity. It is also important to have a general air of confidence within a nation's economy for sponsors to be willing to put their brands on sports such as motor racing.

These shows are the perfect time to engage with areas of new business. I read that the German motor racing scene looks positive for next year across the board, and that will be good news at PMW. PRI shows all the signs of attracting a huge group of hardcore racing buyers to Indy, and the US race scene looks to be emerging from the doldrums. The United SportsCar Championship, whose inaugural race is the Rolex 24 on 25-26 January, brings together an amazing potential grid of 100 sportscars and GTs. I hear that the new technical rules will mean urgent modifications will be required for many of these cars under the 'equivalency' banner. IMSA, the sanctioning body, is working hard to be fair to all competitors, but in doing so, they will create opportunities for some to upgrade and that is good for business. IndyLights are now operating through Petersen Promotions and a new car will be announced any day. There will be good business to be had for that series, which will prove popular in 2015. IndyCar sounds as though it will begin to 'liberate' some supply opportunities from the grip of Dallara during 2014. Drag and off-road racing are both booming and offer plenty of new opportunities, so PRI is a real must-do this year.

Europe comes together at *Autosport* International, which kicks off with the MIA's Low Carbon Racing Conference on Wednesday 8 January. So much is now happening under the banner of low carbon which brings new business opportunities. The recent successful sale of Flybrid has awakened interest in many motorsport companies seeking to get involved in this fast-growing and profitable area of business. Williams Advanced Engineering has led the way, alongside McLaren, Lotus Engineering, Delta Motorsport and others. Formula E is capturing headlines, as well as Lord Drayson's land speed records, and this all heightens awareness of the sales to be made to mainstream automotive OEMs and race series worldwide. As a new country decides to grow its motorsport footprint, in virtually every case they look for an energy efficient series as a starter.

The Low Carbon Racing Conference is the world's largest meeting place of those producing green high performance technology solutions for this growing market and always attracts key influencers and speakers from around the world to bring the delegates up to date. I have to encourage you to go to www.the-mia.com and secure your company's showcase display, or attend as a delegate, as it will be a sell-out due to all of the media hype surrounding this area of business.

You can see from this why I am confident that 2014 could well be the beginning of a breakthrough year for motorsport. The MIA National Survey, which is due to be launched very soon, confirms that the UK motorsport industry should be back to pre-2008 levels in 2014, a tremendous achievement. More importantly to me, however, is that future years now seem really bright with plenty of new, somewhat diverse opportunities opening up that were not there five years ago. The growing links of real business from mainstream automotive and defence gives a real boost to the future and offers security from the fickle world of motorsport sponsorship. These long-term solid industries can offset some of the risks of supplying motorsport, so I foresee a much healthier motorsport business sector being created over the next five years.

Supplying defence is an important growth market for racing companies

One question remains, and that is the role of the FIA under a president to be elected this month. The commercial influence which they can – if they wish – bestow on the motorsport supply industry is huge. Handled carefully and correctly it can create wealth across our industry, but the alternative can bring suppliers to their knees. The move to more energy-efficient turbo engines in F1 is in the right direction, as was KERS in its day. Decisions of this nature can really galvanise the interest of new customers, be they automotive, defence or otherwise. The FIA must use its regulatory influence to help the motorsport supply industry gain new low carbon technology business from automotive.

Some relatively simple rule changes carefully crafted with the direct input from the motorsport supply chain can meet the demands for future technologies which the automotive industry has now made clear through their Technology Road Map of the Automotive Council. These clearly show the direction of technology travel that technology companies wish to take. All the motorsport rule-makers need do is work with their motorsport supply chain to bring in their technologies at the right time, and a prosperous future of the sport would be guaranteed. A great deal hinges on the election of the FIA president and whether the winner has the commercial vision to grasp this opportunity, and more importantly, to see the value of working closely with their friends in the motorsport supply industry and not simply the OEM manufacturers who use motorsport to sell their cars.

Good luck, and please come and visit the MIA stand at the shows over the winter, or come along to one of our business receptions to meet new customers – all of the details can be found on our website. You would be very welcome.

TEST RIGS

Morse Measurements

Salisbury, NC based Morse Measurements have recently added a number of features to their in-house K&C testing systems. First up is a new ride height fixture that allows quick and accurate measurement of ride height on the K&C rig. Traditionally this measurement has been difficult on K&C rigs, due to the lack of a suitable ground plane reference. Useful for sports cars and open-wheel cars, where ride height has a considerable impact on aerodynamic performance, it is also applicable to other vehicle types. The second addition is the integration of a CMM system to their test rig, to give accurate measurement of suspension pickup points and allow for the assessment of component deflection under load.
www.morsemeasurements.com

ELECTRONICS

Bosch MS3 Sport GT3 Cup

Bosch Motorsport has recently released a version of its MS3 ECU for ex-Porsche GT3 Cup cars. By regulation, these came with a locked ECU, but the new unit from Bosch allows for full access to engine control parameters, allowing for hardware changes to be accommodated. Unlike most aftermarket ECUs, the new unit from Bosch integrates directly with the car's existing wiring harness and requires no modification to fit. The ECU carries features such as rpm cut for sequential gearboxes, three map options and asymmetric ignition and fuel timing, while the whole unit is encased in a very compact aluminium housing, weighing just 250g.
www.bosch-motorsport.de

LUBRICANTS

Prolong Nitro oil

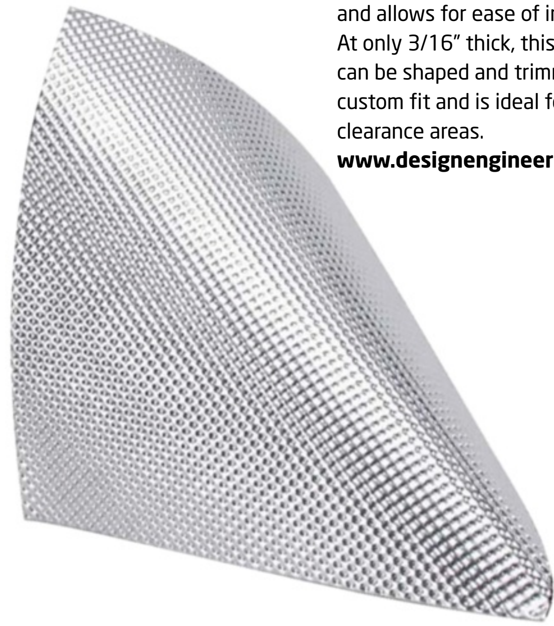
Oil dilution is a fact of life for anyone running a methanol or nitro fuelled drag car, particularly with any form of forced induction. Under extreme cylinder pressures large quantities of fuel invariably end up in the sump, diluting the lubricating oil by anything up to 50 per cent and greatly reducing viscosity. This means that engines tend to be run with much higher viscosity oils than would normally be found in racing applications. To address the specific demands of this type of engine, oil manufacturer Prolong, of Ponoma, California, has recently released a new range of lubricants for these specific applications. Its new Nitro Racing oil is available in 70W and 50W variants and is tailored to provide stable lubrication even when diluted. Beyond simply being a very thick oil, the new lubricants have an additive package that provides a viscosity index of 105 and 135 respectively, ensuring resistance to the high temperatures experienced in extreme applications. The viscosity index represents an oil's resistance to temperature; an oil with a low viscosity index will thin out rapidly as temperatures increase, reducing its effectiveness as a lubricant – particularly at component interfaces that experience boundary lubrication conditions.
www.prolong.com

HEAT PROTECTION

DEI Tunnel shield

Heat protection specialists DEI claim to have made significant improvements to their Floor and Tunnel Shield, and have relaunched the product as Floor and Tunnel Shield II.

Floor & Tunnel Shield II limits heat transfer on fire walls, transmission tunnels, floor boards, fuel cells and other areas where heat is an issue. Constructed with an embossed 10 mil aluminium face bonded to 1/8" composite glass-fibre core and backed with a high temperature, super-strong pressure sensitive backing, it can withstand up to 1750°F of direct continuous heat. DEI also claims its improved multifaceted aluminium surface offers improved reflectivity and rigidity and allows for ease of installation. At only 3/16" thick, this product can be shaped and trimmed for a custom fit and is ideal for minimal clearance areas.
www.designengineering.com



WIRING

Auto Meter EGT Extension Modules to Extend Thermocouple Wiring

Maintaining original wiring length on exhaust pyrometers, also known as Exhaust Gas Temperature (EGT) sensors, is critical for optimum performance. Deviation from or alteration to the thermocouple (sensor) wiring or connectors for these gauges can have a dramatic impact on instrument performance. This issue has previously limited mounting flexibility on a variety of vehicles where the signal processors are required to be located some distance from the engine. To help with this, Auto Meter has developed a pyrometer extension cable for their range of EGT sensors allowing for wiring length of 10ft. to a maximum of 75ft without loss of signal accuracy.
www.autometer.com

FUEL SYSTEM

Quick Fuel Technology's 2-Port and 4-Port Fuel Pressure Regulators

Quick Fuel Technology (QFT) has released two new fuel pressure regulators that feature hard-coat anodized billet housings and internal components that are compatible with gas, alcohol and E85 fuels. Additional protection against corrosion and deterioration include Flourocarbon diaphragms, Viton O-rings, stainless steel pins, brass valve guides and hard-coat anodized diaphragm plates. The 2-port model is rated for up to 650hp, and the 4-port version is intended for applications producing in excess of 650hp.
www.quickfueltechnology.com

EFI CONVERSION

FAST cam signal distributor

Though carburettors still dominate drag racing, many classes now allow the use of electronic fuel injection systems on engines. When converting an existing engine to EFI, one of the key modifications is often the addition of crank and cam signal sensors for inputting into the ECU. To help simplify such installations, injection system supplier FAST has introduced a new distributor unit that incorporates the required sensors to provide such signals. This removes the need for auxiliary sensors and reduces the quantity of engine bay wiring. The sensors are incorporated into a regular distributor body which has been modified to optimise the performance of the new components. As the inside of a distributor is very noisy in terms of electromagnetic interference, the sensor electronics have been shielded to reduce the impact of signal noise on timing accuracy.
www.fuelairspark.com

ELECTRONICS

CARTEK expand range

CARTEK are breaking into the growing market for electrical power distribution systems with the introduction of their new Power Control Panels. As the name suggests, these new products combine customisable switch panels with fully-integrated power switching electronics that are designed to replace multiple switches, relays and circuit-breakers, leading to reduced wiring.
www.cartekmotorsport.com

SENSORS

Variohm EuroSensor expands range

Variohm EuroSensor has expanded its range of competitively priced pressure sensors with the new EPT1400 series for gas and liquid gauge pressure ranges to 250 bar. The miniature 304 grade stainless steel sensor is based on an M8 port configuration in a 14 mm diameter, SW14 body, with a nominal length of 32 mm.
www.variohm.com

HOSES

Lightweight hoses from XRP

XRP has just launched its ProPLUS Race Hose, an anti-static PTFE smooth-bore hose manufactured using a patented process that creates external convolutions on the outside of the tube wall for increased flexibility, and not on the inside where they can impede flow, create turbulence and trap contamination.

The lightweight hose assembly uses Race Crimp Hose Ends, and comes with a choice of three outer braids: SS, lightweight XtraTemp Monofilament, or Aramid Fiber. Compatible with all automotive fluids and fuels, the ProPLUS Race Hose resists fuel permeation and diffusion.
www.xrp.com

TOOLING

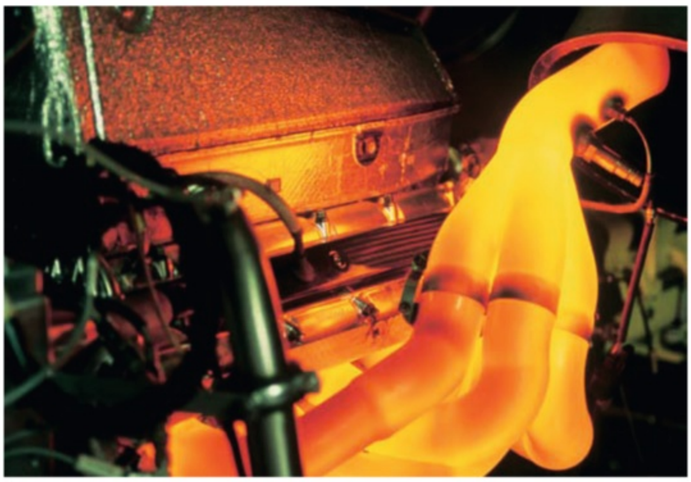
TenCate Advanced Composites expands range

The TenCate AmberTool thermoset portfolio has expanded to incorporate what was formerly known as Amber Composites' HX-series tooling range, with previous tooling prepregs available from TenCate, including 3M's nanosilica fortified resin technology.
www.tencateadvanced composites.com

SENSORS

Sophisticated thermosensors for motorsport success

For more than 30 years, Therma Motorsport has been the partner of choice for high-quality thermosensors for customers across a range of series. They develop proven standard applications and innovative solutions for racing teams – from entry level formulae to professional series such as DTM and Formula 1 – which are comprehensively adapted to the individual technical demands of each customer. The Therma range includes thermosensors for exhaust systems, tyre and braking systems, and fluids, plus display devices and transmitters.
www.therma-motorsport.de



How to get the best out of the *Autosport* trade show

Whether you have made a decision to attend or exhibit in an international exhibition, here are a few tips based on personal experience gained over the last 20 years

Some points and solutions to consider before attending or exhibiting at international exhibitions: logistics, from leasing the space to building the stands; handling goods to and from the exhibition and, of course, tying up all travel and transportation issues with travel services; visa support, hotel accommodation, airport/hotel transfers; exhibition freight handling, on-site handling. My main objective is to point you in the right direction and avoid the many problems you may encounter.

TRAVEL

Very important: You may need a business visa to travel to the US, either to attend or to exhibit at a trade show. If exhibiting you can display samples, sign contracts, and take orders for products made outside the USA. However, you cannot sell or take orders for products made in the USA.

For overseas delegates planning to come to the UK to attend or exhibit at a tradeshow, it is wise to check with the UK customs or immigration. A Google search will be helpful and should provide the appropriate information, while the MIA (Motorsport Industry Association) could also be a good place to start.Most exhibition organisers will be very helpful and will know about local rules of conducting business.

SHIPPING

It is important to find a supplier with experience who offers on-site supervision and lifting services should you require them. It is vital to establish whether they offer supervision and services for pallet deliveries either single or multiple. Even the smallest consignment needs the same expertise as larger consignments.

Again, most exhibition organisers have an operations department that can provide helpful information and a list of shippers. Another tip is to speak to a company already going, and ask them who they would recommend

ACCOMMODATION

All exhibition organisers will have a list of hotels near to the exhibition. It can be a false economy to select a hotel some distance away to save on your budget, and then pay over the difference in taxis.

Try to find a hotel that is very popular with the other exhibitors, as this will enable you to network after the show in the bar. Sometimes some very good business is done after hours.

If you have a loyalty programme with a hotel chain, it can be a good idea to consider using it. I have found hotel business centres to be very useful – for several years, I had my products delivered directly to the hotel.

AIRPORTS AND AIRLINES

Try to fly to the nearest airport to the exhibition, as it will save you hours of extra travelling and time.

If you have a loyalty programme with an airline it is advantageous to try to use it, but sometimes it can be a good idea to shop around. Make sure you keep some business cards on you, as you will often meet other people in the motorsport industry at airports and on your flight. The business of networking starts the moment you arrive at the airport.

RENTAL CARS

Weigh up the cost of renting a car. If you only need transport to your hotel, it may be cheaper to take a cab or ground transport. Many hotels have free shuttles. If you have a programme with a particular company, then check their rates, but most airports have a selection of the leading rental companies.

TIPS

It is vital you take the necessary adaptors for the country you are staying in: check the voltage and plug configurations. It is sometimes impossible to obtain the correct adaptors once you have arrived, and if avaiable they will be expensive.

Make sure you remember the leads for laptops, tablets, iPads and mobiles. I always take a reserve battery or portable charger, as nothing is worse than running out half-way through the day. It happens more often than you think...

Take plenty of business cards as they are one of the most vital assets of your business. If you do run out, take one to the business centre at the exhibition; they will have the facility to print some more for you.

A small folding trolley or travel case with wheels can be very useful; they don't cost much and are worth their weight in gold.

I hope the above will be of assistance to you, and wish you a great show.

Tony Tobias

Sin R1: Just 18 months from concept to road and race cars

A concept born in a meeting at *Autosport* International 2012 and launched at January's 2013 show, the Sin R1 sportscar project will return to Birmingham's NEC for next year's show, with fully-fledged race and road versions.

The vehicle is a joint venture between British company Pro Formance Metals and the newly-formed Sin Car GmbH in Germany, and made its public debut earlier this year on the Daventry firm's *Autosport* International stand, 12 months after the parties first met.

In the nine months since breaking cover, development of the vehicle has continued and it has now contested three rounds of the GT Cup since making its first appearance at Silverstone in August.

'A lot's happened since we started discussing the project at *Autosport* International 2012: if you told us where we'd be 18 months later, starting from a blank piece of paper, I wouldn't have believed you,' explains Pro Formance Metals director Phil Matts.

'We had the prototype Sin R1 at the show in 2013, and we'll be back in January for the 2014 event with full road-going and race versions, ready for the open market.

'There's been lots of hard work and no sleep, but every time the car's been on track in the GT Cup, we've made progress. In the final round, at Donington, we were running second in class at one stage.

'We've already seen a lot of interest in the Sin R1. Several teams are looking at testing it over the winter, and chances are there'll be three or four teams running it in the GT Cup next year.'

The Sin R1 features an FIA-homologated spaceframe chassis from Pro Formance Metals, weighs 1,000kg in race specification, and is powered by a Chevrolet LS7 V8 engine producing approximately 500 bhp.

Fellow *Autosport* International exhibitors AP Racing and M.E.RIN Safety Fuel tanks are involved, supplying brakes and full cell solutions.

For more information about Pro Formance Metals, visit www.proformancemetals.co.uk or Stand 6405, Hall 6 at *Autosport* International 2014.

EEC LAUNCH NEW FUEL BOWSER

Weighing specialists EEC Performance Systems announce their new f-POD Intelligent Race Fuel Bowser. Designed with input from one of the UK's leading single-seater teams, the new bowser has addressed all of the issues raised on conception. With a UK base and technical support, the f-POD offers much more than any market rival.

The 10.2" full colour touch-screen PC, combined with EEC's inspired step-by-step graphical instructions, means that the f-POD is child's play to use, making refuelling errors a thing of the past.

The f-POD can run multiple drivers simultaneously, recording a data history which is available to view instantly on screen and to download via USB.

EEC's patented ATC system ensures the f-POD weighs fuel accurately at any circuit in the world without the need for recalibration.

With safety a priority, all electronic components and the battery are housed in a sealed steel cabinet to eliminate any possible spark risk. The pump uses an explosion-proof motor and ancillary components are ATEX-approved.

The f-POD is CE marked and meets all current applicable directives.

For more details contact EEC Performance Systems on 0044 (0)1455 891623, email enquiries@eec-ltd.com or visit www.eecperformancesystems.com.

You can also visit EEC Performance Systems at the *Autosport* International exhibition stand E342.

International Motorsport Business Week (IMBW) will again bring the industry's key figures together in Birmingham on 6-12 January 2014. Now in its fourth year, IMBW will host a range of focused events to provide a week of extended networking and business opportunities, leading into *Autosport* International.
www.autosportinternational.com/trade

ANSYS BOOKS UP

ANSYS has booked its place at the Autosport Show. The company develops, markets and supports engineering simulation software used to foresee how product designs will behave and how manufacturing processes will operate in real-world environments.

ANSYS simulation tools are used extensively by motorsports teams and are indispensable in developing aspects of race cars, such as air intakes, engine ports, body structures, suspension, engine control electronics and others.

ENGINE VILLAGE

Bookings are now being taken for the new Engine Village organised by The Engine Rebuilder at Autosport Engineering. The Engine Rebuilder serves the interests of engine machinists and rebuilders, and the 'Village' will include companies involved in and supplying this market.

Trade registration

Registration is now open for Europe's largest dedicated motorsport trade show, *Autosport* International 2014. Held at Birmingham's NEC on 9-12 January, the event will again include two days dedicated to industry guests, *Autosport* Engineering in association with *Racecar Engineering*, on 9-10 January. Adult tickets are £26, with discounts available for group bookings. Register now at: **www.autosportinternational.com/trade**

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www.racecar-engineering.com

Peace in our time

Through the fog of GT racing there appears to finally be an accord: a timetable was laid out for the creation and approval of regulations for the new generation of sports car. The plan is to present the regulations to the FIA World Motor Sport Council (WMSC) in June 2014, and to the public at the Le Mans 24 Hours shortly afterwards.

The technical working group appears to have reached agreement between the 16 manufacturers regarding the base model of the GT cars. The only discussions now are the power difference between the new GT and GT Plus (some are looking for 15KW difference, which will lead to a 1.5s lap time difference at Le Mans, others a 30KW difference and a gap of two seconds), with weight a factor. Do manufacturers go for 1200 or 1250kg? Or, as some have requested, 1300kg? What of the engines? Some consider that the cost of producing a racing engine with sonic restrictors is prohibitive; others say that you can only produce racing engines for manufacturer competition, as GT Plus is destined to be.

However, I am not sure that agreement is universal. The idea of growing a GT Plus machine out of the current GT3 car is 'dead in the water' according to several manufacturers. Stephane Ratel, the father of GTE, GT3 and GT4, believes that the base is a GT3 car, and Bentley, which has built one but not raced it must be banking on it being so.

The idea of growing a GT Plus machine out of the current GT3 car is 'dead in the water'

But Vincent Beaumesnil, general manager at the ACO, says that it will be a clean sheet design. 'You must consider that we start from a white sheet of paper to define the future of GT,' he says. 'We do not start from the basis of GT3 or GTE; we define the new set of rules, both in philosophy and process. The target is to define what is common between GT and GT Plus. GT is a more customer-based car, and GT Plus will be the high level GT – like GTE Pro here – but we want to have common parts to make sure that the manufacturer can make one development with two cars with several points that are different, in kits.

'We have agreed on this, but on a few principles like engines that is not decided,' he acknowledges. 'You can have a shape for the two cars and you define some parts that you are allowed some aero development for Plus and not on GT, but you will never hear me say that we will make a GTE or GT3. For me it is a new GT.

'We need to find a balance. The main principle is that all 16 manufacturers agreed. If, at some stage, half don't agree, and want something different, we would stop [this process]. But if 16 say it is in our interests because we save money, we will try to do it. The only reason that we are doing this is to try to save costs. It is very simple. We don't do this for pleasure!'

Porsche welcomed the move, and said if GT3 was the base platform, it would be the end of manufacturer involvement in the World Endurance Championship category. 'From when the discussion started we always said that there needs to be two different cars for two different categories,' said Porsche motorsport director Hartmut Kristen. 'We might have a GT3 category where we want to progress balance of performance, and another category where someone may want to have manufacturers and professional racing in GT. This has to be focussed on a clearer technical definition and would not impact from balance of performance because otherwise it goes crazy.'

Aston Martin agreed. 'The talks are ongoing, but we have the clear view that GTE cars should be separate from GT3,' said team principal John Gaw. 'GTE should be manufacturer cars with sonic restrictors and professional drivers. GT3 should be for customers, and we have been clear all along our point of view. We demonstrated at Silverstone in the Blancpain series what happens when manufacturers race GT3 cars with proper drivers, with a fully optimised car: you beat all the customers.

'My understanding of where things are – that is, the route that will be taken for the future – is that they will be separate cars. There will be common components such as the chassis, but the GTE cars are twice as expensive to run as a GT3 car. Not many customers can afford to run GTE cars, but GTE cars need to be that way because manufacturers, when they get involved, can optimise cars. I don't think that Audi or any of the others should be allowed to race GT3 cars.'

When the process first began in earnest, one representative said that it would help if the manufacturers could all agree on where to start the discussion. It seems that is now pretty much agreed. Once the rules are agreed, we then need the proliferation of series running different iterations of the same car to die out, leaving a clear picture for the long-suffering enthusiast.

EDITOR
Andrew Cotton


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about the new 911 GT3 Cup's
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